THE

Practical Teacher

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'*Knowledge is proud that he has learned so much,*
Wisdom is humble that he knows no more.'—COWPER.

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Hygiene.

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NATURAL VENTILATION—(*continued*).

THE inlets for fresh air must correspond with the size of the room, the uses to which it is to be put, the number of living occupants, and the character of the warming and lighting which is to be in use. The total area of the exits for the used-up air must be quite as large in superficial area as the inlets, and if possible, somewhat larger, so as to correspond with the increased dimensions of the warmed air. The outlets should be more numerous than the inlets; a superficial square foot may be calculated as sufficient outlet for the used-up air of five or six persons or for nine children. It is usual, however, to have the inlets more numerous than the outlets; they should be smaller than the outlets, so as to distribute the admission of fresh air and avoid draught. The inlets must be protected from the influence of the wind, or be so arranged as to be capable of opening on the opposite side of the room to that from which the wind is blowing. Care must be taken that the outlets are not exposed to the force of the wind, otherwise the current is changed, the outlets become inlets, and cold air comes in at the wrong place. It is very important that this possible change be provided for. A large room which is to be used by a few persons only will not require so much ventilating area as one which has occasionally to be crowded with a large audience, such as a concert or assembly room. Again, it must be borne in mind that persons sitting in quiet repose produce much less impurity than persons actively employed. A person asleep evolves less than half a cubic foot of CO_2 in the hour, or 0·5; sitting quietly in his chair it amounts to 0·76; whilst actively employed the amount excreted equals 1·50 per hour. Approximately, we may assume that the figures 2, 3, 5, and 6, will be about the proportions of fresh air which are required, according as the person is asleep, in quiet repose, at gentle work, or working hard. There is another calculation which is based upon the weight of the person for whom the air is required; it is not a sound basis. We must not forget that tissue-change is greater in children and young people than in adults and in the aged. It may be calculated that the quantity of CO_2 excreted per hour in a mixed assembly will be from 0·6 to 0·7 of a cubic foot per person. The quantity of CO_2 produced will be also a measure of the kind of organic impurity, which is most easily detected by the smell. Ventilation which does not take away the evidence afforded by the nose, and which is usually styled 'closeness,' is not a sufficient ventilation. The amount of CO_2 must not be allowed to double the ordinary quantity, for when it passes beyond four parts in 10,000 it is in excess; and if it reaches six or seven parts, the organic matter becomes very perceptible to the senses. Keeping these facts in view we have a guide as to the quantity of fresh air which ought to be admitted every hour. The larger the quantity of CO_2 present in the external air the greater must be the quantity admitted by ventilation. The amount of cubic feet of air or breathing-space per individual, as far as the admission of fresh air is concerned, is not an important factor, as compared with the necessity for air to be admitted into a crowded assembly which is already impure; but if the arrangements are provided in accord with the number of people present, the quantity of air, per hour per person, remains the same. If it is necessary to keep the air perfectly pure, 3,000 cubic feet must be admitted every hour for every person. That quantity will keep CO_2 at or near its normal. The cubic space within is of no importance; but the quantity of air admitted for an adult male should be about one cubic foot per second, to secure perfect purity. If the adults are hard at work—as when engaged in workshops or mines—the quantity admitted must be increased. It has been urged that if it is necessary to keep up the greatest working power of those employed, not less then 100 cubic feet per minute per man should be introduced; but this is far more than that which is usually provided. It must be increased or may be lessened according to the quantity required for fires and lighting, or for the use of animals employed within the area provided for. As regards animals, perhaps the best arrangement will be one which is based upon the weight of the creature. It should be at least a cubic foot per hour for every pound in weight; some writers insist upon one and a half cubic feet. The smaller the animal the greater the quantity of air required. A horse or a cow requires from 10,000 to 18,000 cubic feet per hour.

BRITISH MUSEUM

It is also necessary to make arrangements to get rid of the products of combustion, especially when gas is used for lighting purposes. A cubic foot of gas produces two cubic feet of CO_2. A common burner, producing a flame equal to that in any ordinary street lamp, consumes five feet of gas per hour. Suppose the burner to be alight four or five hours on an average per evening, there are at least forty cubic feet of CO_2 to be removed, and for each cubic foot of gas consumed about 1800 cubic feet of air must be introduced. A common fish-tail or bat's-wing burner requires that from 60 to 70,000 cubic feet of fresh air be introduced to keep down the CO_2 to a normal standard. It is not necessary to provide anything like the same amount of fresh air when ordinary candles are used; neither is the presence of CO_2 which has been produced by lighting arrangements so dangerous as that which is caused by living creatures, for the organic matter detected by the nose is not produced. The apartments which are occupied by sick persons require double the quantity of fresh air to that which is required for those in health.

Cubic Space.—I have said that the principle of ventilation is of greater importance than the simple question of cubic space, but certain arrangements are based upon this question, and it is right to mention the requirements of authorities upon this point. It may be argued that the larger the air space, the less the necessity for frequent removal, and if the rush of air is diminished, so also are the chances of draught. A small room occupied by a certain number of persons will require to have its air changed five times as frequently as a room which is five times larger, but only occupied by the same number of people. Notwithstanding this, authorities insist upon a certain amount of floor space, or of cubic contents, which, however, is far below the absolute requirements for health, as will be at once seen if we compare the measurements required by law with what is stated above:—

In barracks a man is allowed	600	cubic feet.
In wooden huts (in the army)	400	,, ,,
In hospital wards	1,200	,, ,,
In fever wards	3,000	,, ,,
In common lodging-houses from 240 to ...	300	,, ,,
In workhouse dormitories	300	,, ,,
In school-board schools (9 sq. ft. floor space)	80 to 110	,, ,,

But all questions as to floor space occupied by children at school, or cubic space in dormitories, are altogether secondary to the principle of ventilation. If we ventilate a room well, it will accommodate double the number of persons, whilst a badly-ventilated apartment will smell and be unwholesome if only half the number allowed by authority are present in it. Cubic space cannot and must not be allowed to take the place of a frequent change of air.

The cubic space required for animals is capable of perfect regulation, because the animals do not exert their own will, or shut up the ventilators as human beings do. Horses and cattle should have a floor space of from 80 to 120 square feet, and a cubic space of 1,000 to 1,800 feet. The usual allowance in cow-sheds is seldom more than 800, and many of the metropolitan sheds have less than 600 cubic feet per animal. In the army each horse has, according to the army regulations, 100 square feet of floor space, and 1,605 feet of cubic space. In the Horse Infirmary the allowance is 137 feet floor space, and 1,900 cubic space.

Artificial Ventilation is brought about by two different ways. The 'vis a tergo' and the 'vis a fronte.' Air is either driven in, which is called the method of *propulsion*, or it is drawn out, which is styled the method of *extraction*.

Ventilation by propulsion is carried out by means of fans or bellows, or the punkah. It is a certain method, the current can be forced into any place, and the air can be washed in its course. The greatest objection to its use is its cost, and the certainty, sooner or later, of the machine breaking down, usually when most wanted. Ventilation by extraction is also effected by a fan or screw, which draws out the air just as a pump lifts up water, or it is acted upon by a steam jet, by which it is forced into movement in an upward direction, or it is forced into a current by heat. Of these plans the last is the most common. The chimney shaft effects a change of air by the current which it promotes even when the fire is not burning. If the fire is burning it will be in proportion to the size of the fire and the diameter of the chimney. The current is usually from 3 to 6 feet per second. If there is a large fire it will be doubled, and in a furnace fire it is greater still. Those places which were provided as outlets for air, under these circumstances become inlets if the arrangements for the admission of air do not allow of a sufficient supply through the ordinary inlets. If there are not sufficient inlets provided in the ordinary sitting-room, air is brought down from the top of the chimney, and the fire-place puffs out smoke into the room. This is the cause which produces smoky chimneys in a great number of instances. Such may be at once cured by providing a proper supply of air. The main use of a chimney for ventilating an apartment is the constant upward current which the fire produces. The fire not only consumes the oxygen, but the chimney acts as an exhauster for the room, by taking up a quantity of air which has not been burnt. The change from the large open chimneys to those now in fashion, in which only air which has been consumed by the fire is used, has led to a large diminution in the ventilating power of chimneys, and diminished the healthiness of the living rooms of the wealthy. It is an instance of the way in which so-called civilization and the study of the beautiful is cultivated at the expense of health. The principle of extraction is also used when gas jets are burned in shafts which are provided as outlets, and when it is necessary to establish a current upwards, a combination of gas jets with shafts, so arranged, that the heated air passes out into the open without entering the apartment, but which is so managed that the used-up air heats the cylinder conveying it. It is a good and cheap arrangement, the heat from the cylinder being conveyed into the room to be warmed. By this means heating and ventilation are made subservient to one another. Gas may be used for this purpose with great advantage. Hot-water pipes are sometimes used for a similar purpose. The objections to hot-air shafts are the inequality of the draught, and the alterations which take place from the changes of temperature outside, caused by increase or decrease in the number of people, or the simple alteration consequent upon rises and falls of the barometer and thermometer.

Measurement of Cubic Space.—Length, breadth, and height being obtained, these are multiplied into each

other; it is a simple plan, and the quotient is the answer to the question; but allowances must be made for recesses, for furniture, and for occupants. It is always best to measure by feet and decimals of a foot. If inches are given, they may be turned into square feet by multiplying by ·007. Rules for measurement of triangles, circles, and segments of a circle will be found in the ordinary works on measurement. In measuring a room with a sloping roof, such as a cow-shed or marquee, it is best to take the length, breadth, and height, to the slope, first calculate that portion, then, bearing in mind that the area of a triangle equals its base multiplied by half its height, an approximate estimate may be easily obtained, and when this is arrived at, the quantity of fresh air which must be admitted may be calculated.

Following the syllabus laid down by the authorities at South Kensington, we find the subject of closets, of sinks and baths, to be connected with the removal of waste and impurities, and we take them in order accordingly.

Closets.—These include water-closets, earth closets, middens, privies, cesspools, or any other contrivance for the disposal of human excreta.

Water-Closets are alone suitable for large towns, unless there is an absolute scarcity of water, a commodity which no town is justified in allowing to be scarce. The w.c. should never be placed in or near the centre of a building, but always on an outside wall, and, if possible, in an annexe so that the connection with the sewer may be altogether outside the main wall of the building. No w.c. should be allowed to remain without through ventilation, that is, two communications with the outer air, when the door is shut which leads from the house into the closet. There should be a kind of ante-chamber between the house and the closet, which should have a window; there should also be a window in the closet itself; these windows should not be on the same level. There should always be a cistern for the supply of the closet, and from which water should never be used for dietetic purposes. The overflow pipe from the cistern should not discharge into the w.c. itself, but be so arranged as to act as a tell-tale if the cistern, which is now usually called a waste-water preventive cistern, gets out of order.

(*To be continued.*)

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The New Class-Subject, 'Elementary Science.'

(What to teach, and how to teach it.)

BY RICHARD BALCHIN.

ADOPTING a plan similar to the one sketched for the lower standards, I propose giving the teacher's notes of lessons in this subject of 'Elementary Science' for Standard V. The complete syllabus of the year's work appeared in last month's issue of this magazine. I repeat that these lessons fully embrace the work in the first stage of the specific subject, chemistry, for which the 'Science Reader' for Standard V. (Hughes') forms a good text-book. Perhaps I ought to state that these exceedingly simple notes are intended only as suggesting the plan of lessons, which, after an experience of a quarter or a century, I have found the most effective in presenting the various facts to the minds of boys in the most practical, and, at the same time, most educative manner.

LESSON I.

MATTER AND ELEMENTARY BODIES.

Distinguish between 'matter' and 'non-matter'—between material things and immaterial things. Chalk, wood, ink—material things—can be weighed, measured, handled. Sound, light, electricity—immaterial things—cannot be weighed, handled, etc. Can have a pound of chalk, or a pint of ink; cannot have a pint of light, or a pound of sound. There are different kinds of matter. The matter of coal not the same as that of milk. Some substances made up of more than one kind of matter. Burn chalk, and we get lime—*i.e.*, the heat has expelled something from the chalk and left lime. Therefore, chalk consists of at least two kinds of matter. At the gasworks, coal is heated, a gas is obtained and coke is left. Therefore coal consists of at least two kinds of matter. Burn a candle in an inverted glass vessel over water; the candle soon goes out, and some of the enclosed air has disappeared; what remains is different from ordinary air. Therefore air consists of at least two different kinds of matter. But whatever we may do to gold, iron, lime, sulphur, etc., we cannot find anything else but gold, iron, etc. These consist of but *one* kind of matter, and are called elements. There are about sixty-six known elements. Written language consists of written sentences; sentences of words; words of letters. And here we stop. Letters are the elements of a written language.

LESSON II.—COMPOUNDS.

Letters are the elements of a written language. Letters put together in a certain manner form words. So elementary substances when united in a certain manner form compounds. Oxygen is an element; so is carbon. Burn a piece of carbon (charcoal) in a jar of oxygen gas—*i.e.*, combine the carbon and oxygen, and we get carbon dioxide, CO_2, a compound. Heat some red oxide of mercury in a test-tube. The inside of the tube is lined with the metal mercury and oxygen comes off. Therefore the red oxide of mercury is a compound consisting of the elements oxygen and mercury. Solids unite to form gases: mix a small quantity of powdered charcoal, of powdered sulphur, and of saltpetre (nitrate of potash); set fire to this mixture of solids; they combine and form gases. Place a few fragments of phosphorus (dried) upon a plate; throw upon them a small quantity of iodine; the two elements combine and form a red solid called iodide of phosphorus. Gases unite and form solids: moisten the inside of one tumbler with strong solution of ammonia: place a card over it; moisten the inside of another tumbler with hydrochloric acid, and invert it upon the card on the first tumbler. Both glasses are now filled respectively with the gases of ammonia and hydrochloric acid. Gently draw the card from between the glasses: the gases unite and form dense white fumes, which is solid chloride of ammonia.

LESSON III.—COMPOSITION OF CHALK.

Show picture of chalk pit and limekilns. Chalk is burnt; lime is left. Carbon dioxide is expelled. Therefore chalk consists of lime + CO_2. The lime

that is left contains oxygen. Pure lime we call calcium. Lime, therefore, is an oxide of calcium, CaO. On some pieces of chalk in a beaker, pour some hydrochloric acid. Dip a lighted taper in the vapour rising in the glass; taper goes out in the carbon dioxide driven from the chalk. Hydrochloric acid unites with the remaining lime to form chloride of lime. Do the same with fragments of white marble; hence lead to the general composition of all limestones—*e.g.*, Portland and Bath stones, mountain limestone. Also shells of mollusca, coral reefs, etc. Repeat the burning of carbon in oxygen and recapitulate the explanation of CO_2. Chalk is therefore a compound formed of one part of calcium, one part of carbon, and three parts of oxygen. We write it, $CaOCO_2$; or, $CaCO_3$.

As to the lime, it may be explained that CaO is oxide of lime or quicklime. If water, H_2O, be poured upon it, the quicklime becomes slaked lime, which is hydrate of lime, $Ca(OH)_2$. If chlorine be passed over slaked lime, we get chloride of lime, or bleaching powder. If the boys are above the average in mental capacity, the experiment with chalk and hydrochloric acid may be explained from this point of view, the acid being $HCl + H_2O$.

Lesson IV.—Red Oxide of Mercury.

Why say *red* oxide of mercury? We do not say *white* oxide of lime, or *red* oxide of iron. Because there is *another* oxide of mercury, the *black* oxide. Heat a small quantity of mercury in a test-tube over a spirit lamp, and direct a stream of oxygen upon the boiling metal. At first red scales appear; this is the red oxide, HgO. Instance of combination of elements to form compound. Heat some red oxide in a test-tube over a spirit lamp; the compound splits up; oxygen comes off as a gas; the metallic mercury comes off as the metallic vapour, which condenses upon the inner sides of the test-tube, and forms countless globules of the liquid metal, or, as the boys will probably remark, 'makes the tube like a looking-glass.' Instance of 'decomposition,' as it is termed in the Code Syllabus.

If there is time, another common compound of mercury may be noticed, viz., sulphide of mercury, HgS, (vermilion, or cinnabar; this latter being an ore of mercury, a red-looking stone.) It should also be explained that mercury remains liquid until a cold is reached 72° (−40°) below the freezing-point (32°) of water, when the mercury becomes solid.

Lesson V.—Mixtures and Compounds.

Mix some very fine iron or steel filings with powdered sulphur, 47 parts of iron to 53 of sulphur. Place some of this mixture in saucer No. 1. Burn the rest in an iron saucer over the Bunsen burner. Take a piece of the solid dark-looking substance from the iron saucer, and powder it; place this in saucer No. 2. Pass a magnet over the powder in No. 1; the grains of iron leave the sulphur, and attach themselves to the magnet, leaving the sulphur, which may be ignited by a hot iron wire. This shows that neither the iron nor the sulphur have changed or lost their respective properties by being brought together in this way. Pass the magnet over the powder in No. 2; no iron is abstracted, neither will the powder ignite, showing that when combined in this way, the iron and the sulphur have both lost their respective properties, and we have a substance which is neither iron nor sulphur; it is the sulphide of iron. Mix some powdered charcoal (carbon), sulphur, and saltpetre (nitrate of potash). Place a pinch of the mixture under a microscope; the grains of the several substances are easily distinguishable. No change has occurred. Set a light to the powder, and the whole, or nearly the whole, combines to form various gaseous compounds.

Decompose the compound water by means of the metal sodium, and separate the oxygen from the mixture air by means of phosphorus, as described in the 'Reader.' After these experiments, the boys will supply definitions of 'a mixture,' and 'a compound.'

Lesson VI.—Compounds.

Make solutions in water of the following substances, which very readily dissolve:—Nitrate of lead (No. 1); iodide of potassium (2); chloride of mercury—corrosive sublimate (3); sulphate of iron (4); sulphide of ammonium (5)—this solution had better be purchased; sulphate of zinc (6); infusion of galls (7.) All the above should be quite *clear*. They should be kept in stoppered glass bottles, labelled and numbered. Have a number of test-tubes on a stand, and proceed to form the following compounds:—

Mix No. 1 with some of No. 2. Result:—the formation of iodide of lead, of a brilliant yellow colour.

No. 3 and No. 2. Result;—iodide of mercury, of a brilliant scarlet colour.

No. 4 and No. 5. Result:—sulphide of iron, perfectly black.

No. 6 and No. 5. Result:—sulphide of zinc, perfectly white.

No. 4 and No. 7. Result:—tannate of iron (ink), black.

The above resulting compounds being insoluble in water, are precipitated. The precipitate should be obtained by the two methods of (1) evaporation; (2) filtration.

(*To be continued.*)

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Physiology.

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Chapter XI.—CIRCULATION OF THE BLOOD —(*continued*).

The Circulatory Organs.—The *heart* forms the central organ of the circulation, from which blood is constantly being propelled to every part of the body, and to which it is returned. It is a hollow, egg-shaped organ, lying in the thorax in an oblique position, with the apex downwards and to the left, and the base upwards. On each side it is almost covered by the lungs, a small central uncovered portion being left behind the sternum.

The apex of the heart can be felt beating between the fifth and sixth ribs, about two inches below and an inch nearer the sternum than the left nipple. The base of the heart lies under the sternum on a level with the third costal cartilages. This part of the heart is

comparatively fixed, owing to its connection with the great vessels which run into and from it.

The heart, as well as the commencement of the great vessels, is enclosed in a conical bag, called the *pericardium*. This consists of two layers, an external fibrous layer, which is very strong, and an internal serous layer, which is connected with the outer surface of the heart, and then reflected over the inner surface of the fibrous layer; thus forming a closed or serous cavity, the inner surface of which is beautifully smooth, and secretes a small amount of thin fluid which facilitates the movements of the heart.

In the adult, the heart is 5 inches long, and 3½ inches wide at its base. Its weight in men varies from 10 to 12 ounces, in women from 8 to 10 ounces; its relative proportion to the weight of the whole body being as 1 to 169 in males, and 1 to 149 in females.

The heart is divided longitudinally by a muscular partition into two lateral halves, and a transverse division divides each lateral half into an upper and lower cavity, auricle and ventricle respectively. The right is the venous side of the heart, receiving into its auricle the blood from the veins of the whole body except the lungs; while the left side of the heart receives into its auricle the arterial blood from the lungs.

External grooves indicate the division of the heart into four cavities. A deep transverse groove, known as the auricular-ventricular groove, indicates the separation between auricles and ventricles.

Two inter-ventricular grooves run obliquely down the front and back of the ventricles respectively, separating the two ventricles. The point of junction of the large veins with the two auricles is not marked by the presence of any valves, but for about half an inch from the heart these veins acquire transverse muscular fibres like those of the heart.

Between the right auricle and ventricle is a valve, called the *tricuspid valve*, owing to its presenting three cusps or pointed portions; while at the corresponding point on the left side of the heart, the valve is called the *bicuspid* or mitral, as it has only two chief projecting portions, though there are intervening smaller ones. Each portion of these valves is of triangular form, the base being firmly attached to a ring-like membrane, which encircles the auriculo-ventricular orifice, and serves for the common attachment of the valves and of the separate muscular fibres of the auricles and ventricles. The different valves are joined at their bases, while their apices and sides lie free in the ventricular cavity, except at the moment the ventricle contracts, when they come closely in contact. This contact during the heart's contraction, which prevents any reflux of blood, is further ensured by the attachment of slender tendinous fibres to the free borders and under surface of the valves. These tendinous fibres are known as *chordæ tendineæ*, and they are fixed below to the inner walls of the ventricles, the muscular fibres of which project at intervals in the form of small bundles or columns, called *columnæ carneæ*. Now the *columnæ carneæ* are of three kinds; some are fixed throughout their length to the ventricular wall others are fixed only at their two ends, while a third kind (called *musculi papillares*) are fixed at one end into the ventricular wall, the other end projecting into the cavity, and having attached to it *chordæ tendineæ*.

If these parts be examined in a sheep's heart, the attachment of the chordæ tendineæ to the musculi papillares below, and to the under surface and edges of the auriculo-ventricular valves above can be easily observed, and it will be evident that the effect of contraction of the ventricles and of the musculi papillares which form a part of them, is to draw on the chordæ tendineæ, and cause them to keep the valves in close juxta-position, and prevent any floating back of the valves into the auricular cavities.

Fig. 43.—Theoretical section of Heart, showing the four cavities and origin of large vessels.
(*a*) Aorta; (*bb*) Pulmonary arteries, arising from a common trunk; (*c*) Superior vena cava; (*dd*) Right and left pulmonary veins; (*f*) Right auricle; (*g*) Left auricle; (*h*) Inferior vena cava; (*i*) Right ventricle; (*k*) Left ventricle; (*l*) Inter-ventricular septum.

The ventricles communicate, on the one hand, with the auricles, from which they are separated by the auriculo-ventricular valves; and on the other hand, with the two large arteries (the pulmonary artery and aorta), which carry blood from the heart. The junction of each of these with the ventricle is guarded by three valves, called *semilunar valves*, the only difference between those on the left side of the heart (aortic) and those on the right side (pulmonic), being that the former are thicker and stronger. Each of these valves is formed, like the auriculo-ventricular valves, of fibrous tissue, covered with the delicate lining membrane of the heart or *endocardium*. As the name indicates, each valve is semi-circular in shape, being attached to a fibrous ring at the point of junction of the heart and artery, and projecting inwards. There are no chordæ tendineæ, as in the auriculo-ventricular valves; but each valve is strengthened by a minute fibrous nodule at the centre of its free edge, where the three valves come into contact and become pouched out when the blood makes a futile attempt to return from artery to ventricle.

The main substance of the heart consists of striped muscular fibres, the peculiarities of which have been already described. The muscular fibres of the auricles are quite distinct from those of the ventricles, and we shall find that the two auricles always contract together, driving out their contents, while the ventricles do likewise, immediately after the auricles have finished their work.

The heart requires nutrition, like every other organ of the body, and has therefore a special vascular supply of its own. Its nervous supply is derived from the sympathetic system and the vagus nerve.

The Arteries.—From the left side of the heart, a large arched vessel, called the aorta, carries the blood to every part of the body. From this main trunk branches are given off, which again divide and subdivide, each branch diminishing in size, until the minute capacity of capillaries is arrived at. The total area of all the branches of an artery is greater than that of the original artery. Similarly the area of a trunk vein is much less than that of the smaller veins from which it is formed. The capacity of the minute

arteries, and veins, and capillaries, is thus much greater than of the other parts of the vascular system, and we might represent the arterial and venous systems as two cones, the bases of which join at the capillaries. We know that when a stream widens the current of the water becomes slower; and this is true likewise of the vascular system.

The various arteries in their course anastomose, branches joining together. This is of great importance when any artery becomes obstructed by disease, or severed by accident. The collateral branches usually suffice to carry sufficient blood to the part, and avert dangerous consequences.

Arteries are usually situated in protected parts. Thus at the elbow and knee, they are on the flexor side, and deeply situated. When they are liable to injury from stretching, arteries will be found to be tortuous, thus allowing for tension.

Each artery consists of three coats, an internal or epithelial, a middle or muscular, and an external or fibrous coat. When an artery is tied by a ligature, the two inner are separated from the external coat, and obstruct the flow of blood.

The *inner coat* consists from within outwards of (1) a layer of pavement epithelium, the cells of which shew distinct nuclei. This epithelium is continued throughout the whole of the vascular system, lining the heart and blood-vessels, and giving their interior a beautifully smooth and shining appearance. (2) A sub-epithelial layer, consisting of homogeneous connective tissue, in the midst of which are branched connective-tissue corpuscles. (3) A number of layers of elastic and white fibrous tissue. The innermost of these consists of longitudinal elastic fibres, in which by means of the microscope small apertures may be seen, whence the name given to it by Henle of *fenestrated membrane.*

The *middle coat* consists of unstriped muscle cells, arranged circularly to the course of the vessel. This coat is thicker and redder in proportion in the smaller vessels, in the larger vessels there being a predominance of elastic fibres.

The *external coat* consists mainly of connective tissue, with a variable amount of longitudinally arranged elastic tissue, in all but the smallest arteries, in which elastic tissue is absent.

All the larger arteries are supplied, like every other part of the body, with blood-vessels, called *vasa vasorum.* They supply the external and middle coats with blood, the internal coat probably deriving its nutrition by osmosis from the interior of the vessel. Arteries are likewise supplied with nerves, chiefly derived from the sympathetic system.

The Capillaries.—Harvey, when he discovered the circulation of the blood, had not the advantage of a microscope. He was, therefore, unaware of the minute capillary circulation, which, except in the case of the spleen, the placenta, and certain cavernous structures of the generative organs, forms the means of communication between artery and vein. The transition from arteries to capillaries is very gradual, but the capillaries themselves maintain the same diameter throughout their course. Each capillary consists of a single layer of elongated, flattened, and nucleated cells, forming a delicate continuous membrane, outside which there is usually a structureless, or delicately-fibrillated membrane. The most common diameter of a capillary is $\frac{1}{3000}$th of an inch, though smaller ones are found in the brain and follicles of the intestines, and larger ones in the skin and medulla of bone and elsewhere. The form of the capillary network, into which an artery divides, may be elongated or more rounded, while the distance between the individual capillaries may be less than the width of the capillary, as in the lungs and choroid coat of the eye; or about the same width as the capillaries themselves, as in the human liver; or three or four times the width of the capillaries, as in the human kidney.

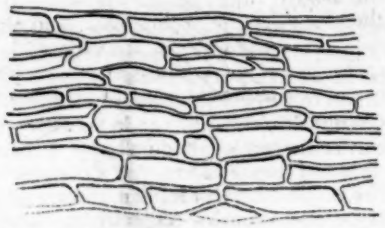

Fig. 44.—Instance of Elongated Capillary Network, as seen in a Voluntary Muscle.

The length of any given capillary probably never exceeds $\frac{1}{30}$th part of an inch. The closeness of the capillary network, and consequently the vascularity of any portion of the body, are in close relation to the activity of its functions.

The Veins.—The general structure of a vein is similar to that of an artery, consisting of three coats having a similar arrangement. There are certain minor differences, however.

(1) The *internal coat* is less brittle than that of an artery, and seldom shows a fenestrated membrane.

(2) The *middle coat* is thinner than that of an artery, and contains a larger proportion of yellow and white fibrous tissue.

(3) The *external coat* is similar to that of an artery, but thicker, and in some veins contains muscular fibres.

The general consequence of these differences is that veins when seen after death are flat and collapsed, while arteries retain their circular shape.

The internal coat of veins presents at intervals semilunar folds, forming *valves*, the free edge of which is turned towards the heart. Generally the valves are placed opposite each other. When the blood is flowing towards the heart, these lie in close apposition to the wall of the vein, but on any attempt at reflux they become pouched inwards, as seen in Fig. 45.

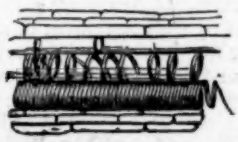

Fig. 45.—Illustrating action of Valves in Vein in preventing reflux of blood.

Valves are commonly absent from veins of less than a line in diameter, and in those which are not subject to the pressure exerted by muscular contractions. The superior and inferior vena cava, the veins entering and leaving the liver, the renal and pulmonary veins, may be mentioned among those which are destitute of valves.

We have already mentioned the prolongation of striated muscular fibres from the auricles for a shor

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distance into the vena cava and pulmonary veins. There are certain other veins which present peculiarities. In the veins of the gravid uterus, muscular tissue is largely developed, while it is entirely absent from most of the veins of the brain and pia mater, from the veins of the retina, and of the cancellous tissue of bones, and a few other parts.

Veins generally accompany arteries in their course, the currents in the two being parallel, but in opposite directions. They are usually larger than the arteries they accompany, and not uncommonly there are two veins to one artery. Thus the venous system is much more capacious than the arterial. The pulmonary veins form an important exception to this rule. Many veins running in and under the skin are not accompanied by arteries, and in certain internal organs the course of the two does not correspond.

(*To be continued.*)

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Article 106 (*b*).

Merit Grant in Infant Schools.

BY MRS. MORTIMER,

Lecturer on Kinder-garten at the Home and Colonial Training College, London.

Section II.—Phenomena of Nature.

LESSON—NIGHT AND DAY.

SUPPOSING the lesson to be given in the morning, the teacher should begin thus. When do you go home? What do you do? Have our dinner. And after dinner what do you do? We come to school again. What do you do when school is over? We go home, play about a little after tea, and then go to bed. What part of the day is it when you are in bed? It is night-time. Can you tell me anything about the night? Well, I suppose you cannot tell me much about it as you are all sleeping then. I dare say, however, some of you can tell me something if you try. One little boy says it is quite dark and very quiet. Another one says if we look out of doors we shall see the moon and the stars. Where shall we see them? In the sky. That is quite right; the moon and stars are in the sky. When can we see them? At night. Perhaps some of you remember that we had a long talk about them a little while ago. When does the night begin? When it begins to get dark. What do we call it then? The evening. When does it begin to get dark? When the sun goes down. What do you say the sun does when it goes down? We say the sun sets. Then the evening begins when the sun sets. All of you say, 'The evening begins at sunset.' When does the night end? When it begins to get light. And when is this? When the sun rises. Then you see we can say: 'The night begins at sunset and ends at sunrise.' Is the night always the same length? I am afraid that is too hard for you. Perhaps you can tell me if the sun always shines the same time each day? When does it shine the longest? In the summer. And when does it shine the shortest? In the winter. When shall we have the longest days? In the summer. And if we have long days, what kind of nights shall we have? Short ones. Yes; then all of you say: 'In the summer we have the longest days and the shortest nights.' Now, I daresay you notice that after tea you can no longer go out and play like you did in the summer-time. Is it because you have your tea sooner? Oh, no, we do not have our tea sooner. Well, Mary, what are you going to say? Yesterday the teacher had to light the gas before we went home. Well, then, what shall we say? The day is over sooner now. Yes, and that means that the night begins sooner. In the summer it was quite light when you had to get up, but now what are you obliged to do? Mother has to give us a candle. Yes, and that shows you that the day does not begin so soon, and that the nights are longer. So you see in the winter the nights are longer. All of you say: 'In the winter we have the shortest days and the longest nights.'

Now, what do we call that part of the day when the night ends? The morning. What does the sun do then? It rises. Yes, and it keeps on rising until it is high in the sky. What part of the day is it then? We call it *mid-day*. Yes; and sometimes *noon*.

What do you mean by mid-day. The middle of the day. Yes; what do you generally have then? Our dinner. And what do you call the part of the day after dinner? We say it is *afternoon*. Can you tell me one name for morning, noon, and afternoon? That is right. It is the day. What do your mothers and fathers do then? They work all the daytime. What does your mother do? Keeps the house clean, cooks the dinner, etc. And your father? He goes out to work. How does he seem when he comes home? Very tired. Yes; and then you ought to be quiet and go to bed. Do your mothers and fathers go to bed directly it gets dark? Then how do they see? They have candles or lamps or the gas. Why do they not go to bed? Because they have work to do. Yes; and also because they do not want as much sleep as you do. Little children want a great deal of sleep, it helps them to grow strong. Why do we work in the day and not in the night? Because we can see better in the day. And what else? The night is better for sleeping. You said the middle of the day was called midday, what do we call the middle of the night? *Midnight*. What time is it then? Twelve o'clock. And which part of the night do we call the *evening?* The first part.

Section III.—Scenes of Common Life.

LESSON—A FARM.

If this lesson be given to country children the teacher will have no difficulty in getting them to describe the farm. In giving the lesson to London children, the teacher will have to depend upon the children who have visited the country, and a good picture of the farmyard will be of great service.

Who knows what I mean by a farm? Who has been to a farm? Jane says she went to a farmhouse last summer, so we will ask her to tell us what she saw, and then see if we can find any of the things she tells us about in this nice picture.

What is a farmhouse? It is the house where the people of the farm live. Do you mean all the people that work on the farm? No; the master of the farm and his family. What do we call the master of a farm? The farmer. Where do we say the farmhouses are? They are in the country. Yes; and very often they stand quite by themselves, with no other house near. You might have to walk for many hours before you come to another house. Now, can you tell me what the farm is? Yes, the farmer has a great deal of land on which he grows a great many things. Can you tell me some of the things the farmer grows? Corn, potatoes, hay, and fruit. Yes; he also grows beans, clover, turnips, and many other things. Then he has a number of sheds called barns, in which he puts all these things. And other places for the animals to live in. Can you tell me some of the animals the farmer keeps? Pigs, cows, sheep, fowls, and horses. These live also in the fields. Do you know what grows in these fields? Grass. Well, all these fields, and yards, and barns are called the farm. You now see how it is the farmer often lives a long way from any one else. Which part of the year do you like to go to a farm? In the summer-time. Why? Because everything is growing nicely, and we can run about the fields, and go into the yard and see the fowls and ducks. Does the farmer see to all these places and

animals himself? Oh no, he has several men and women to help him. When you were at the farm what were these men doing? They were cutting down the long grass. What do they do with this long grass? They toss it about and leave it in the field to dry. What do they call it then? They call it hay. Did you like the haymaking? Yes; it was great fun to roll in the hay. You were playing; but the men could not do that, they had to work. You could leave off when you liked, but they were obliged to keep on until they had put the hay up into large stacks, called hayricks. If you had gone to the farm later in the summer you would have seen the farmer's men cutting the corn. Who has seen a cornfield? See, here is one after the corn has been cut. The corn is now in bundles. These bundles are called sheaves, and are very often tied up by women. The corn is then taken to the farmyard and threshed. Do you know what this does? Yes; it knocks the grains of corn out, and only the long stalks are left. What do we call the long stalks of corn? Straw. The grain is sent to the miller, and what does he do with it? He grinds it into flour. Now you have told me that the farmer makes hay and cuts the corn. What must he do to make the corn come? He must sow the seed in the ground. What does he do to the ground first? He has to dig it up. Yes; when your father wants some flowers in the garden, he digs the ground, and then he sows the seed. Now look at this picture. (The teacher points to a picture of a plough.) Do you see these iron knives, and the long handles, and the horses? Well, this is called a plough, and the farmer digs his fields with this. It would take too long to dig the large fields with spades like we do our gardens. When the ploughing is finished the farmer sows the corn, and the turnip-seeds, and other things he wants to grow. While these things are growing (the farmer calls them his crops), the farmer has other things to do. He has to look after the sheep and other animals, and see that they have nice food. What do they eat in the summer? The grass in the fields. Yes; and the farmer grows turnips, potatoes, and other things for them. What do we get from the sheep? Wool. Yes; in the spring the farmer takes the sheep to the pond, and there the men wash the sheep, and then cut all the thick, long wool off. Do you know why he does this in the spring? I will tell you. The sheep do not want all the wool in the warm weather, and so the farmer cuts it off when the summer is coming, and sells it to men who make cloth and flannel of it. Then the cows are very useful, and the farmer must see to them. What do we get from the cow? Milk. Yes; the women milk the cows every morning and evening. What is done with the milk? Some of it is sold, and the rest is made into butter and cheese. Yes, some day I will tell you how the milk is made into butter and cheese. What other animals must the farmer look after? The pigs. Yes; these he fattens and sends to the butcher. What does the butcher call the pig when it is killed? Pork and bacon. The farmer also sells his sheep and cows to the butcher. What do we call the flesh of sheep? Mutton. And that of the cow? Beef. So you see we get our meat from the farmer. Can you think of anything else the farmer has to do? Yes; he must look after the chickens and ducks. Yes; and some farmers keep turkeys and pigeons. What do we get from the fowls and ducks? Eggs. Yes; and the farmer sells all these birds for food. The part of the farm where these birds are kept is called the poultry-yards.

You see, then, the farmer besides looking after the fields has many other things to do. He generally has one particular person to look after the poultry-yard. She goes out regularly to feed the poultry, and it is great fun to see how the fowls and the ducks and other birds all run to her when she comes. Do you know what she gives them? Then she takes away the eggs, and sees that the men keep the place clean.

The children should then write on their slates the names of all the animals on the farm, the different things grown on the farm, and the different kinds of work carried on.

Section IV.—Common Employments.

LESSON—THE GLAZIER.

Apparatus.—A small window frame, a diamond, a rule, hammer, knives, brush, glass, and putty.

Now, children, tell me some of the things that a carpenter makes? Doors, cupboards, windows, tables, etc. Which part of the windows does he make? The wooden part. What do we call that? The window-frame. What else has to be done to finish the window? The glass has to be put in the frame. Does the carpenter do this? What do we call the man who puts in the glass? Yes, that is right, he is called the 'glazier.' Now let us to-day try and find out what the glazier has to do. You have already told me that he puts the glass in the frames. What must he do before he puts it in? Well, here is a piece of glass and a window-frame. Look at it. Could the glazier put it into the frame? Why not? Because it is too large. What must he do? He must cut the glass. Could you cut it? With what does the glazier cut glass? No, not with a knife. See, here is a knife, and you see it will not cut the glass, and yet it is very sharp, for it very easily cuts this piece of wood. He uses a *diamond*. See, here is one. What can you see? A long handle made of wood. What is this at the end? It looks like lead. Yes, it is lead. What can you see in the lead? Something that shines—a piece of glass. It is not glass, but a diamond. Have you ever heard of diamonds? Who has seen one? Where? In a locket. Yes, they are put in lockets and rings because they are very bright and pretty. When next you see them you must notice how they sparkle. Well, this is only a very small one, and not so bright as those in the rings and lockets. Now look, and I will try to cut this glass. Have you seen anything like this? Yes, it is a rule. Well, you place the rule on the glass, and then placing the diamond close to it, you press the diamond on the glass and draw the diamond along. What have I done? Drawn a line on the glass. Try and rub the line off. You cannot. What should we say then? We have scratched a line on the glass. Yes, the diamond has not cut right through the glass. You now take hold of the glass and it breaks very readily along the crack. When the glass has been cut the proper size what next must we do? We must put it in the frame. But see, there is some of the old glass in the frame, so what must we do? Take it all out. How does the glazier do this? He knocks it out. What does he use? A hammer and a knife. Yes, and besides taking out the glass, what else does he do? He takes out all the old putty. Who has seen the glazier using a brush like this? For what? For brushing out any small pieces of glass or putty. Yes, it would not do to use our hands. Can you tell me why? Because the very small pieces of glass might get into our fingers. Now the frame is quite clear, what has to be done? The glass has to be put in. What do you call a piece of glass like this? A pane of glass. Who can put this pane in for me? That is right, but when you take your hand away what will happen? It will fall out. Well, what else do we want? Some putty. Who can find me the putty? What can you tell me about it? It is of a light colour. Anything else? Yes, it is soft. Can any of you show me how the glazier puts the putty on? Yes, he puts it all round the window-frame, and then puts the glass in. What else does he do? He smoothes the putty. How does he do this? With his knife. Is this the knife he used before? No, it is a very smooth one, and not the same shape. The teacher should show the two knives and let the children notice the difference in them. The smooth one is called the glazing or stopping knife, and the other the chopping or hacking knife. Now when the putty is put in and smoothed nicely over, the work is not quite finished. You see the putty is of a light colour, and the window frame is black. What do you think the glazier would do? Yes, he would paint the light putty to make it like the window-frame. You said the putty was soft, and yet the man had to chop out the old putty. Was that soft? Well, then, what would you

say? The putty dries and gets very hard. Yes, and we have to be careful not to rub the window very hard at first. Now tell me all the things the glazier has to do, and write on your slates the names of all the things the glazier uses in his work.

(*To be continued.*)

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Friedrich Fröbel.

BY HIS PUPIL, HEINRICH HOFFMAN.

X.—(*continued.*)

The first Kinder-garten established in Hamburg was conducted by Frau Doris Lütkens, a lady who not only distinguished herself by her professional ability, but who also edited an educational periodical. With untiring energy she laboured to promote the Kinder-garten, and was most ably assisted by a favourite niece of Fröbel, Allwine, the daughter of Middendorff. This young lady afterwards became the happy wife of one whose name will for ever rank among the most zealous writers on the Kinder-garten system, Dr. Wichard Lange, the successful proprietor of a large boys' school which continues to merit the high esteem of the most influential classes in Hamburg. In conjunction with Fröbel he published *Friedrich Fröbel's Wochenschrift*, a weekly paper on the Kinder-garten system (Liebenstein, 1850), and it is to him, who stood in such close connection and constant intercourse with the leading members of the united families, that we owe most of the literature on Fröbel and his work. His lucid style has rendered his writings very popular with all German educationists.

Through the influence of Frau von Marenholtz, the Duke of Meiningen generously offered Fröbel his hunting-box near Marienthal, about a mile and a half distant from Liebenstein, a residence beautifully situated, and close to a charming wood. Here Fröbel enjoyed the evening of his life amidst a large number of pupils, who were boarders, and who revered their paternal friend with touching devotedness. This institute Fröbel designated, in allusion to the end and aim of all his life's aspirations, as *Allseitige Lebens einigung*, a term the exact equivalent of which it is difficult to find in English. (*Allseitig* means all-sided, that which satisfies, or is complete in every direction; *Lebens einigung*, harmonization, unification, of life.)

In order to convince the masses of the excellent results of his plans, or rather, to demonstrate the oneness of all his many contrivances, he arranged a grand festive playing match on the Altenstein, near the ducal palace, on the 4th of August, 1850, the first of its kind ever held. Three hundred children assembled from Salzungen, Meiningen, and the neighbouring villages, and under Fröbel's personal direction performed the various games and gymnastic exercises of the Kinder-garten, to the admiration and delight of a vast number of spectators. It was a day memorable in the history of the Kinder-garten, on account of the immense impression it made, and the enthusiasm it excited in old and young.

The domestic affairs in Marienthal were conducted by a lady who for many years had belonged to the most devoted and most faithful of Fröbel's adherents. But she had long been more to him; she was his intimate friend and regular correspondent. With a clear understanding she combined deep piety and thorough goodness of heart. Her amiability, and the refinement of her manners, won her the affection of all who came near her. We mentioned her name already, when speaking of some pupils of Keilhau. Fraulein Luise Levin was destined to become his second wife in July, 1851. It proved indeed one of those happy unions which we fondly designate as being made in heaven. Pure and holy affection blended the two into one, and the sweet cherub of thorough domestic happiness and contentment took up its abode for awhile in Marienthal, with every one of its many inmates.

Alas! but for awhile! Joy and sorrow are but too often closely linked in this world of ours, and Fröbel's life, apparently made up of dire changes, was destined once more to experience the mutability of all things terrestrial.

As with all human affairs, it was impossible to keep the new idea altogether intact and unpolluted by improper hands. It naturally attracted the attention of all sorts of people, and elements were here and there introduced, to Fröbel's regret, which he abhorred. On the whole, perhaps, he confided too much in the goodness of men, and wherever he found warm reception, he was too ingenuous to suspect improper motives. He judged men after his own standard, believing them to be as pure-minded and noble as himself. Sad disappointments were the necessary consequence. Narrow-minded people would eagerly lurk for anything that might serve to engender distrust, would raise suspicion, and search for flaws. Perhaps, in the order of things, this may be a natural and necessary law, nothing at least proves so much productive of good in purifying a noble cause from anything that is unworthy of it. So we need not wonder that frequently Fröbel's high-souled principles were confounded with such as were objectionable in religious or political parties. But wonder we must at the incomprehensible error which the Prussian Government committed under the ministry of Herr von Raumer.

On the 7th of August, hardly one month after his marriage, a very severe blow was dealt at the work of his life by a ministerial decree, which prohibited the Kinder-garten throughout the entire kingdom of Prussia. The edict opened with the strangest bit of reasoning, thus:—'From a pamphlet, written by *Karl Fröbel*, entitled *Ladies' High Colleges and Kinder-garten*, it appears that the Kinder-garten forms part of the Socialistic system, which aims at training children to atheism. These institutions, therefore, cannot be tolerated.'

It will be remembered that Fröbel, in pious reverence of his deceased brother, Christoph, pastor in Griesheim, had founded his first institute for the benefit of his nephews. One of these was Karl Fröbel, a man of honourable character and of deep learning. The society which had invited Fröbel to Hamburg had appointed him headmaster to a newly-established Ladies' High College. But uncle and nephew differed so much on many essential points, that Friedrich Fröbel repudiated his nephew's principles altogether. Karl Fröbel now lives in Edinburgh. But what must surprise us most is, that the views held by *one* man should have been attributed to another, whose principles were totally different! Every effort to convince the minister of his gross mistake entirely failed. Fröbel sent in all his publications, and offered to undergo a personal examination. But it was all in vain. This strange prohibition remained in force until 1861. In

the eyes of all thinking men there was certainly no need for him to refute the monstrous charge, yet nothing seemed to himself so urgent. Day and night he wrote, whilst from every point of view the ministerial decree was elucidated and repudiated; under the natural excitement the reply enlarged to a volume of such dimensions, that its completion necessarily exceeded his physical powers. Indeed, it was never completed. Though his mind was unbent, his sublime trust in the divinity and in the final victory of his cause remained unshaken. Once, when I ventured to express my feelings with reference to this unparalleled attack, he replied: 'Did you not hear of the wheat found with the mummies in the pyramids? wheat that must have lain there, shut out from the world, for more than three thousand years? And did you hear how Lord Stanhope was permitted to sow a few of these grains, and what an enormous harvest they have yielded? Well, my Kinder-garten is such another grain of wheat. They may close it, they may shut it up in a tomb stronger than the pyramids for another three thousand years, still it will rise, and will flourish; no human power will be able to destroy its vitality, for it is permeated with the everlasting essence of God.'

Indeed, the disastrous storm which had caused so much mischief could not touch the enchanted island in which he dwelt—his beloved Marienthal. Here amidst a circle of sympathising and faithful friends he found peace and happiness, and no one knew better how to enjoy it than Fröbel. That his beautiful garden and grounds were not altogether devastated; that many and many a plant was saved, nay, had grown but stronger, he should learn to his great joy, when at Michaelmas, 1851, a meeting of educationists, in Liebenstein, after three days' discussion, bestowed the highest encomium on him and on his work. Another most gratifying day was his 70th anniversary, 1852. Whatever love and veneration could suggest, whatever mind and heart could plan, to render it a high festival of pious reverence, was realised in a most touching manner.

The last ray of glorious sunshine, however, that illuminated his path, was another great assembly of teachers, at Whitsuntide, 1852, in Gotha, to which he had been formally invited. On his entering the densely-crowded hall, all rose from their seats, the chairman welcomed him in an enthusiastic speech, and offered three times a 'Hoch!' This meeting proved how utterly flat the official censure had fallen on the masses in general, and filled poor Fröbel's heart with warm and refreshing sunlight.

But his physical strength began rapidly to decline. On the 6th of June, 1852, an illness befell him, from which he should not recover but as a citizen of heaven; it was with the setting sun of the longest day, the 21st of June, that his great soul unfolded her wings for the blessed flight home.

The mournful story of his last illness, final departure, and his funeral obsequies, has been most touchingly recorded by Wilhelm Middendorff, in a pamphlet, *Friedrich Fröbel's Ausgang aus dem Leben.*

One year later, November 13th, 1853, and this exemplary friend followed him to the heavenly abode.

Now they are all gone—the united friends—to be reunited in heaven, save Frau Louise Fröbel, who lives in Hamburg, and is still active in the sacred cause, her noble soul ever animated with the memory of her immortal friend. Dr. Wichard Lange is still in full health and vigour, labouring with youthful energy. Keilhau still flourishes as a first-class Institute under the able management of Dr. Siegfried Schaffner, the son-in-law of Christian Fröbel. Although Fröbel and his associated friends have been recalled from their labours, their work lives and flourishes, and with increasing cordiality is their watchword adopted in all parts of the globe—

'COME, LET US LIVE FOR OUR CHILDREN.'*

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My Certificate Answers.

BY ARTHUR DAY,

Assistant-Master, Bridge Street, 7th Standard Technical School, Birmingham; First in the First Class at the Borough Road College, Christmas, 1883.

Algebra and Mensuration.

2. Prove that in taking the square root of a number when $n+1$ digits in the root have been obtained by the ordinary rule, n more may be found by simple division.

Ex. Find $\sqrt{2}$ to 5 places of decimals.

Let N = the given number whose root is required,
a = the part found and having $n+1$ digits,
x = the part to be found and containing n digits,

Then $\sqrt{N} = a+x$

$\therefore N = a^2+2ax+x^2$

$N-a^2 = 2ax+x^2$

$\frac{N-a^2}{2a} = x + \frac{x^2}{2a}$

Now x contained n digits, so x^2 cannot contain more than $2n$ digits,

But a is made up of $n+1$ digits in front of n o's

So that $\frac{x^2}{2a} = \frac{2n \text{ digits}}{(2n+1) \text{ digits}}$, that is, it is a proper fraction, and neglecting this we have $\frac{N-a^2}{2a} = x + \text{some remainder.}$

Ex.

$$\begin{array}{r|l} 2\cdot & 1\cdot414 \\ 1 & \\ \hline 24) 100 & \\ 96 & \\ \hline 281) 400 & \\ 281 & \\ \hline 2824) 11900 & \\ 11296 & \end{array}$$

$$\frac{2-(1\cdot414)^2}{2\cdot828} = \frac{\cdot000604}{2\cdot828} = \cdot000213$$

$1\cdot414213$. Ans.

3. Solve the equations:—

(1) $4(x-a)^2 = 9(x-b)(a-b)$

(2) $x^2+y^2 = 74$

$x^3+x^2y+xy^2+y^3 = 888$

(1) $4(x-a)^2 = 9(x-b)(a-b)$

Multiplying out: $-4x^2+4a^2-8ax = 9ax-9bx-9ab+9b^2$

Arranging: $-4x^2-(17a-9b)x+(4a^2+9ab-9b^2) = 0$

$4x^2-(17a-9b)x+(4a-3b)(a+3b) = 0$

Factorising this expression,

$\{4x-(a+3b)\}\{x-(4a-3b)\} = 0$

Therefore $x = \frac{a+3b}{4}$, or $4a-3b$.

(2) $x^2+y^2 = 74$

$x^3+x^2y+xy^2+y^3 = 888.$

$x(x^2+y^2)+y(x^2+y^2) = 888$

$74(x+y) = 888$

$x+y = 12$

$x^2+2xy+y^2 = 144$

$x^2+y^2 = 74$

$2xy = 70$

$xy = 35$

* Many of the facts and dates of this essay have been gathered from Dr. W. Lange's *Autobiographiches von Fröbel*, a book previously referred to; and from Bruno Hanschmann's *Friedrich Fröbel, Die Entwicklung seiner Erziehungsidee in seinem Leben.* My own personal recollections were most kindly aided by liberal communications from Frau Louise Fröbel. H. H.

$$x^2+y^2-2xy=74-70$$
$$(x-y)=2$$
$$\begin{cases} x+y=12 \\ x-y=\ 2 \end{cases}$$
$$2x=14$$
$$x=7$$
$$2y=10$$
$$y=5$$

7. The population of a town increases annually 4 p.c., what proportionate addition will be made to the population in a period of 10 years?

log 1·04 = ·017033. log 1·48 = ·170330

y = the amount 1 will increase to

In 1 year 1 increases to 1·04
In 2 years 1 ,, $(1\cdot04)^2$
In 10 ,, 1 ,, $(1\cdot04)^{10}$

Therefore $(1\cdot04)^{10}=y$
$10 \log 1\cdot04 = \log y$
$10(\cdot017033) = \log y$
$\cdot17033 = \log y$
but $\log 1\cdot48 = \cdot17033$
Therefore $\log 1\cdot48 = \log y$
$\therefore\ y = 1\cdot48.$

The population will increase 48 on every 100 of the original number. Ans.

10. A man who walks up hill at the rate of 2½ miles an hour, and down hill at the rate of 5 miles an hour, ascends and descends a hill in 6 hours, how many miles did he walk, and what was the height of the hill, the rise being 1 in 8?

Let x = time taken in descending (in hrs.)
Then $2x$ = ,, ,, ascending ,,
$x+2x=6 \quad \therefore\ x=2$ hrs.

Therefore the distance walked is 20 miles, and the height of the hill ⅛ of 10 miles = 1¼ miles. Ans.

1. If a quantity is a factor of two other quantities A and B, it is also a factor of $m\mathrm{A}\pm n\mathrm{B}$. Prove this and state its application to determining G.C.M. of two algebraical expressions.

Let K be a factor of A and B, and let $a\mathrm{K}=\mathrm{A}$, and $b\mathrm{K}=\mathrm{B}$.
Then $ma\mathrm{K}=m\mathrm{A}$ and $nb\mathrm{K}=n\mathrm{B}$.
$\therefore\ m\mathrm{A}\pm n\mathrm{B}=ma\mathrm{K}\pm nb\mathrm{K}=\mathrm{K}(ma\pm nb)$
That is, K is a factor of $ma\pm nb$.

Suppose the following to be a G.C.M. :—

B) A (r
rB
C) B (s
sC
D) C (t
tD
...

In the above $A=rB+C$, $B=sC+D$, $C=tD$. D divides C, therefore by the former proof it divides $sC+D=B$. D divides B and C, therefore divides $rB+C=A$. Therefore D is a common factor of A and B.

Again, every factor of A and B will divide $A-rB$ (according to our proof).
But $A-rB=C$.
Also, every factor of B and C divides $B-sC=D$. Therefore every factor of D is a factor of A, B, and C.
But nothing larger than D can divide D, therefore D is G.C.M.

9. Prove by induction or otherwise that the sum of the series

$$1^3+2^3+\ldots\ldots+m^3=\frac{m^2(m+1)^2}{4}$$

By Induction. By trial we find

$$1^3+2^3=\ 9=\frac{2^2\times3^2}{4}$$
$$1^3+2^3+3^3=36=\frac{3^2\times4^2}{4}$$

We see the rule holds for 2 and 3, digits. Now assume it to hold for k, and let $k+1=m$.

Then $1^3+2^3\ldots\ldots k^3=\frac{k^2(k+1)^2}{4}$

To each side add $(k+1)^3$

$$1^3+2^3\ldots\ldots(k+1)^3=\frac{k^2(k+1)^2}{4}+(k+1)^3$$
$$=\frac{(k+1)^2\{k^2+4(k+1)\}}{4}$$
$$=\frac{(k+1)^2(k+2)^2}{4} \quad \text{But } k+1=m$$
$$=\frac{m^2(m+1)^2}{4}$$

Therefore if it holds for k, it holds for $k+1$; but it holds for 3, therefore it holds for 4, and therefore it holds for 5, and so on universally.

4. A man who saved every year half as much again as he had saved in the previous year had at the end of eight years £26 5s. 5d. How much did he save in the first year?

Let x = amount saved 1st year.
Then $x(\frac{3}{2})$ = 2nd year's savings.
And in successive years
$s=x+x(\frac{3}{2})+x(\frac{3}{2})^2\ldots\ldots x(\frac{3}{2})^7$
This is a Geom. Series.

$$s=\frac{(\frac{3}{2})^8-1}{\frac{3}{2}-1}.$$
$$£26\ 5s.\ 5d. = \frac{x\left(\frac{6561-256}{256}\right)}{\frac{1}{2}}$$
$$6305 \text{ pence} = x\frac{6305\times2}{256}$$
$$1d. = \frac{x}{128} \qquad x = 128 \text{ pence.}$$

10s. 8d. Ans.

8. If the number of permutations which can be formed by n things taken 3 together = $56n$, find n.

$$P=n(n-1)(n-2)$$
$$56n=n(n-1)(n-2)$$
$$(n-1)(n-2)=56$$
$$n^2-3n+2=56$$
$$n^2-3n-54=0$$
$$(n-9)(n+6)=0$$
$$n=9$$

9. Ans.

5. (1) If $\frac{a}{b}=\frac{c}{d}=\frac{e}{f}$ then each fraction $=\frac{ma+nc+pe}{mb+nd+pf}$.

Synthetic Method. $\frac{a}{b}=\frac{c}{d} \therefore \frac{a}{c}=\frac{b}{d}$

Multiply each side by $\frac{m}{n}$, then $\frac{ma}{nc}=\frac{mb}{nd}$

add 1 to each side, $\frac{ma}{nc}+1=\frac{mb}{nd}+1$

$$=\frac{ma+nc}{nc}=\frac{mb+nd}{nd} \quad \therefore \frac{ma+nc}{mb+nd}=\frac{nc}{nd}$$
$$\therefore \frac{ma+nc}{mb+nd}=\frac{c}{d} \quad \therefore \ =\frac{e}{f}=\frac{pe}{pf}$$
$$\frac{ma+nc}{mb+nd}=\frac{pe}{pf} \quad \therefore \frac{ma+nc}{pe}=\frac{mb+nd}{pf}$$

Add 1 to each side, $\frac{ma+nc}{pe}+\frac{pe}{pe}=\frac{mb+nd}{pf}+\frac{pf}{pf}$

$$\therefore \frac{ma+nc+pe}{pe}=\frac{mb+nd+pf}{pf}$$
$$\therefore \frac{ma+nc+pe}{mb+nd+pf}=\frac{pe}{pf}=\frac{e}{f}=\frac{a}{b}=\frac{c}{d}.$$

(2) If $\frac{y+z}{3b-c}=\frac{z+x}{3c-a}=\frac{x+y}{3a-b}$

then each fraction $=\frac{x+y+z}{a+b+c}=\frac{ax+by+cz}{a^2+b^2+c^2}$

$$\frac{y+z}{3b-c}=\frac{z+x}{3c-a} \quad \therefore \frac{y+z}{z+x}=\frac{3b-c}{3c-a}$$

Add 1 to each side, $\frac{y+z}{z+x}+\frac{z+x}{z+x}=\frac{3b-c}{3c-a}+\frac{3c-a}{3c-a}$

$$\therefore \frac{y+2z+x}{3b-2c-a}=\frac{z+x}{3c-a}=\frac{x+y}{3a-b}$$
$$\therefore \frac{y+2z+x}{x+y}=\frac{3b-2c-a}{3a-b}$$ and by adding 1 and changing sides } as before
$$\frac{2y+2z+2x}{2b+2c+2a}=\frac{x+y}{3a-b}$$
$$\therefore \frac{x+y+z}{a+b+c}=\frac{y+z}{3b-c}=\text{ etc.}$$

Mensuration.

3. A hemisphere is partially hollowed so that the interior surface is a right cone with its vertex on the surface of the hemisphere, and with the same base; when the cup thus formed is filled with water, it weighs one-fourth more than when it is empty; find the ratio of the density of the material of which the cup is composed to the density of water.

Vol. of a cone = area of base $\times \frac{1}{3}$ height.
Vol. of hemisphere $= \frac{2}{3}\pi r^3$.
Let r = radius of hemisphere
then vol. of cone $= \pi r^2 \times \frac{r}{3} = \frac{\pi r^3}{3}$

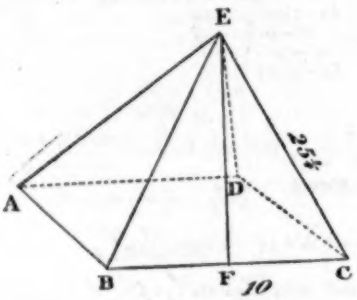
Therefore the cone is half the volume of the hemisphere.
Let D denote the density of water.
" D_1 " " " cup.
Then

$$\frac{\text{Weight of cup}}{\text{Weight of water}} = \frac{D_1 \times \frac{\pi r^3}{3}}{D \times \frac{\pi r^3}{3}} = \frac{1}{4}$$

$\therefore \frac{D_1}{D} = \frac{1}{4}$.

Therefore the density of the cup is four times that of the water.

1. A pyramid stands on a square base; a side of the base is 10 feet, and each of the edges is 25 feet 3 inches long; find the area of the surface of the pyramid.



Area of base $= 10^2 = 100$ sq. ft.

$$FE^2 = EC^2 - FC^2 = (12\frac{1}{4})^2 - 5^2 = 150\frac{9}{16} - 25\frac{0}{16}$$

$$FE = \sqrt{125\frac{9}{16}} = 23\frac{3}{4} = 24\frac{1}{4} \text{ ft.}$$

Area of EBC $= EF \times FC = 24\frac{1}{4} \times 5 = 121\frac{1}{4}$ sq. ft.
Area of 4 triangular sides $= 4$ (area of EBC) $= 495$ sq. ft.
Area of surface $= 595$ sq. ft. Ans.

French.

SECTION I.—A.

1. Translate into English one of the given selections, and parse the words in italics, and give the principal tenses of the irregular verbs in the passage.

Dumorbion *lui* demanda son épée et posta *des* gendarmes à la porte de son appartement, où entrèrent aussitôt plusieurs officiers supérieurs, qui, *voyant* prisonnier celui qu'ils venaient saluer comme leur général, *firent* éclater, au péril de *leur* vie, une indignation chaleureuse: plusieurs même exhortèrent Hoche à se soustraire par la fuite à l'exécrable tribunal devant *lequel* tout prévenu était d'avance un condamné. Hoche *s'y* refusa. Il répondit qu'il se devait à lui-même de paraître devant ses accusateurs, et qu'il ne voulait point donner un exemple qui *pût* servir d'excuse aux traîtres dans l'avenir *ou* dans le passé. Il *leur* parla longtemps avec un sang-froid et une tranquillité qui ne se démentirent pas. Après avoir exposé de quelle manière il croyait que la guerre allait être *conduite* en Italie, il les *pria*, s'ils étaient *de nouveau* témoins de quelques grandes injustices sans doute inévitables, *de* ne pas suivre les conseils d'une irritation toujours funeste. Tous ceux qui étaient présents, ses aides-du-camp surtout, *fondaient* en larmes, mais *lui*, le front serein, le regard toujours fier et doux, s'efforçait *à les* rassurer.

Dumorbion asked him for his sword, and stationed some gendarmes at the door of his apartment, in which entered many superior officers, who, seeing a prisoner he whom they were coming to salute as their general, showed, to the peril of their lives, a warm indignation; many even urged Hoche to avoid by flight the execrable tribunal before which all arraigned were condemned in advance. Hoche refused to do it. He replied that he owed it to himself to appear before his accusers, and that he did not wish to give an example that might serve as an excuse to traitors either in the future or in the past. He conversed with them for some time with a composure and tranquillity that did not belie him. After having explained in what manner he believed the war was about to be conducted in Italy, he prayed them, if afresh they were witnesses of some great injustices undoubtedly inevitable, not to follow the counsels of an always fatal irritation. All those who were present, his 'aides-du-camp' above all, were bursting in tears; but he, with calm brow, his expression continually proud yet sweet, forced himself to reassure them.

Lui—pron., conj., pers., sing., 3rd, masc., complement of 'demanda.'
des—partitive article, plural.
voyant—verb, irr. (voir, voyant, vu je vois, je vis, je verrai), imperfect participle.
firent—verb, irr., 4th conj. (see below for parts), act., trans., ind., past def., plu., 3rd, ag. with subj. 'officiers.'
leur—possessive pronoun.
à—preposition, governing 'tribunal.'
lequel—rel. pronoun, sing., masc., relating to 'tribunal.'
s'y—se, y.
se—reflective pronoun.
y—adverb of place.
pût—verb, irr., 3rd conj., subj., imperf., sing., 3rd, ag. with subj. 'exemple.'
(Subjunctive because following 'voulaient.....que,' expressing a wish.)
ou—conjunction.
leur—pron., conj., pers., plu., 3rd, com., complement of 'parla.'
conduite—past participle of 'conduire.'
pria—verb reg., 1st conj., act., trans., ind., past def., sing., 3rd, ag. with subj. 'il.'
de nouveau—adverb of time.
de—preposition, forming part of verb 'suivre.'
fondaient—verb, reg., 4th conj., neut., ind., imperf., plu., 3rd, ag. with subj. 'ceux (personne).'
'lui'—(used instead of 'il' for emphasis) pron., pers., sing., 3rd, masc., subj. to 's'efforçait.'
à—preposition, connected with 's'efforçait.'
les—pron., conj., plu., 3rd, comp. of 'rassurer.'

Irregular Verbs:

Voir, voyant, vu,
Je vois, je vis, je verrai.
Faire, faisant, fait,
Je fais, je fis, je ferai.
Prevenir, prevenant, prevenu,
Je previens, je previns, je previendrai.
Paraître, paraissant, paru,
Je parais, je parus, je paraitrai.
Vouloir, voulant, voulu,
Je veux, je voulus, je voudrai.
Pouvoir, pouvant, pu,
Je peux, je pus, je pourrai.
Dementir, dementant, dementi,
Je demens, je dementis, je dementirai.
Croire, croyant, cru,
Je crois, je crus, je croirai.
Aller, allant, allé,
Je vais, j'allai, j'irai.
Suivre, suivant, suivi,
Je suis, je suivis, je suivrai.

2. Explain the construction of interrogative sentences in French, and translate into French—

'Has she any silk?' 'Yes, she has some.' 'Are you ill, madam?' 'Yes, I am.' 'Are you the Baron's daughter?' 'Yes, I am.'

In interrogative sentences the verb is made to precede its nominative; in compound sentences the auxiliary only is transposed.

A-t-elle de la soie? Oui, elle en a. Avez-vous malade, madame? Oui, j'ai. Etes vous la fille du Baron? Oui, je suis.

3. Translate into French :—

He attends to everything himself; he takes no rest, and allows none to his soldiers. 'Rest,' he says, 'is the rust of courage.' It is winter, the cold is severe, and he does away with tents as useless baggage in a Republican army; the regiments bivouac in the open air; the forests of the Vosges give them shelter and supply their fires; a regiment murmurs and demands winter quarters; Hoche causes it to be entered in the orders of the day that this regiment shall not have the honour of taking part in the action in the first battle. The soldiers of this corps conjure him to revoke an order in which they see an intolerable affront; they take an oath to expiate their fault by their bravery, and they will keep their word.

Il attends à tout lui même; il ne prend aucun répos et n'en donne aucun à ses soldats. 'Le répos,' dit-il, 'est la rouille du courage. C'est en hiver le froid est sévère et il supprime les tentes comme un bagage inutile dans une armée Republicaine: les regiments bivouaquent en plein air, les forêts des Vosges les arbitent et alimentent leurs feux; un regiment murmure et demande des cantonments d'hiver; Hoche fait mettre à l'ordre du jour que ce regiment n'aura point le honneur de participer à l'action dans le premier bataille. Les soldats de ce corps le conjurent de revoquer une ordre où ils voient un intolerable insult; ils jurent d'expier leur faute par leur bravoure et ils tiendront parole.

4. Explain the allusions in the following passages :—

(*a*) 'On eût dit Socrate, au milieu de ses disciples avant de boire la ciguë.'

(*b*) 'En proie au feu qui le dévorait, il se disait revêtu, comme Hercule, de la robe empoisonné du Centaure.'

(*c*) 'Hoche se sentait menaçé par un pouvoir muet et invisible; l'épée de Damocles etait sur sa tête.'

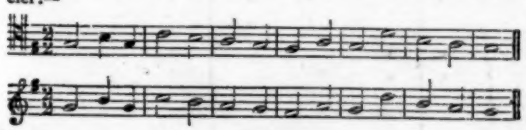
(*a*) Socrates, the Grecian philosopher, had many followers, and Hoche comforting his friends before going into captivity is compared for his calmness to Socrates, who drank a cup of hemlock and poisoned himself.

(*b*) The fever that Hoche suffered from is compared to the robe of the Centaur that Hercules slew and which robe he wrapped himself in.

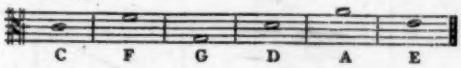
(*c*) Damocles was a courtier of Dionysius, and owing to injudicious remarks, found at a banquet a sword suspended over his head by one hair.

Music.

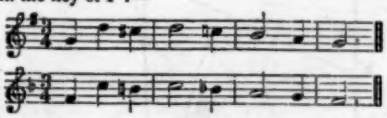
1. Write the following passage one octave higher in the Treble clef :—



2. Under each of the following notes write its letter-name (as C, D, E, &c.) :—

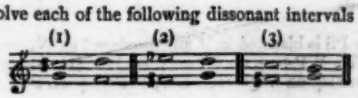


4. Write the following one tone (a major second) lower, namely in the key of F :—



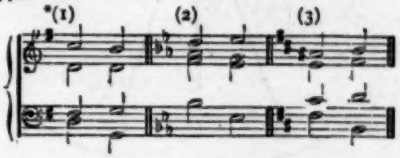
5. Write under each of the following intervals its name (minor third, &c.) :—

8. Resolve each of the following dissonant intervals :—

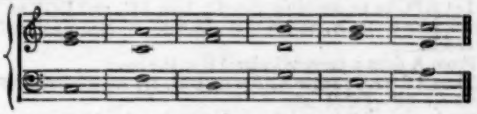


9. Resolve each of the following discords (in four-part harmony) :—

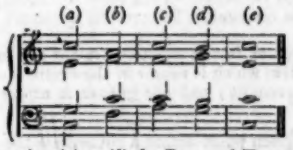
10. Resolve the following direct forms of the dominant seventh :—



11. Complete each of the following common chords (in three parts when completed), by adding (as an Alto part) the note here omitted :—



12. Point out the grammatical faults in the following progressions :—



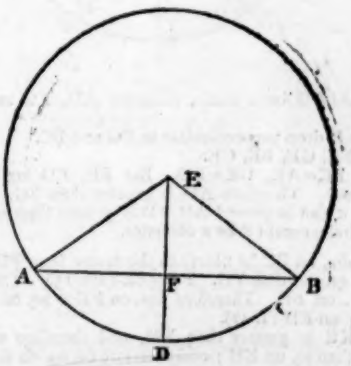
In the progression (*a*) to (*b*) the Bass and Tenor parts move in fifths.

At (*c*) (*d*) (*e*) the Tenor and Treble are in octaves, adding to which fault the chord (*d*) has the leading-note doubled.

Euclid.

If a straight line drawn through the centre of a circle bisect a straight line in it which does not pass through the centre, it shall cut it at right angles; and if it cut it at right angles it shall bisect it.

If with the vertex of an isosceles triangle as centre a circle be described cutting the base or base produced, the parts of it intercepted between the circle and the extremities of the base will be equal.



Let AB be a chord, and EF another passing through the centre E.

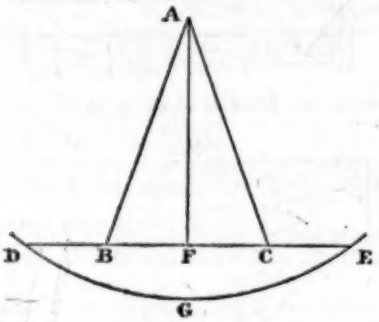
First let EF bisect AB in F.

Then AF = FB (hyp.), AE = EB (I. def. 15).

And the base EF is common. Therefore angle AFE = EFB (I. 8).

Therefore AB is at right angles to EF (def. 10).

Next let EF be at right angles to AB.
Then AE=EB angle EAF=FBE, angle EFA=EFB.
Therefore AF=FB (I. 26).



Let ABC be an isosceles triangle, base BC, and DGE an arc struck with centre A, and cutting the base or base produced in D and E.

From A drop a perpendicular AF to the base.

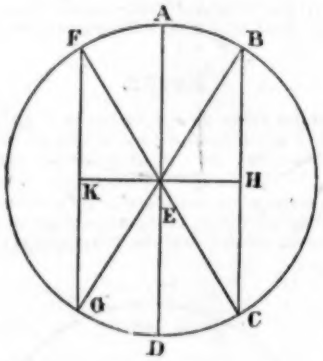
Then AB=AC; angle ABF=ACB (I. 5); angle BFA=AFC; therefore BF=FC (I. 26).

But because AF is at right angles to the chord DE, DF=FE (III. 3).

DF=FE and BF=FC. Take away the equal parts from the whole, and the remainders DB and CE are equal.

4. The diameter is the greatest straight line in a circle; and of all others, that which is nearer to the centre is always greater than one more remote; and the greater is nearer to the centre than the less.

Through a given point within a circle draw the least possible chord.



Let ABCD be a circle, diameter AD, FG and BC other chords.

From E drop perpendiculars to FG and BC.

Join FE, GE, BE, CE.

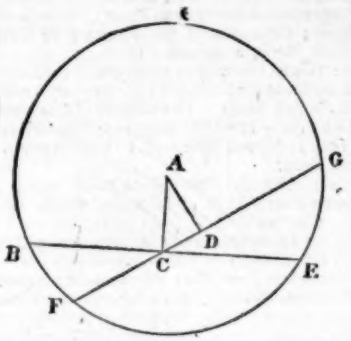
Then FE=AE, GE=ED. But FE, EG are greater than FG (I. 20). Therefore AD is greater than FG. In the same manner it can be proved that AD is greater than any other line in the circle, except it be a diameter.

Secondly, let BC be nearer to the centre than FG. Then BC shall be greater than FG. FE=BE (def. 15). Therefore sq. on FE=sq. on BE. Therefore sqs. on FK + sq. on KE=sq. on BH+sq. on EH (I. 47).

But KE is greater than EH, and therefore sq. on EK is greater than sq. on EH; and therefore the sq. on KF is less than the sq. on EH.

Therefore FK is less than BH. But FG is double of FK, and BC double of BH (III. 3). Therefore BC is greater than FG.

Thirdly, let BC be greater than FG, then EH shall be less than KE. For, as before, sq. on FK+sq. on KE=sq. on BH+sq. on EH. But FK is half of FG, and BH half of BC (III. 3), and BC is greater than FG; therefore FK is less than BH, and sq. on BH is greater than sq. on FK. Therefore sq. on KE is greater than sq. on EH



And KE is greater than EH.

Let C be the given point. Join C to centre A, and through C draw BE at right angles to AC, then BE is the least possible chord.

Draw any other chord FG. From A drop AD perpendicular to FG.

In the triangle ADC the angle ADC is a right angle; therefore ACD is less than ADC, and therefore AD is less than AC (I. 19).

Therefore FG is greater than BE (III. 15). In the same way it can be proved that all chords through C are greater than BE.

To divide a straight line PQ into two parts, so that the rectangle contained by PQ, QR, may be equal to the square on PR.

Prove that rect. PQ, PR+sq. on PR=sq. on PQ, and that rect. PQ, RQ+rect. PR, RQ=rect. PQ, PR.

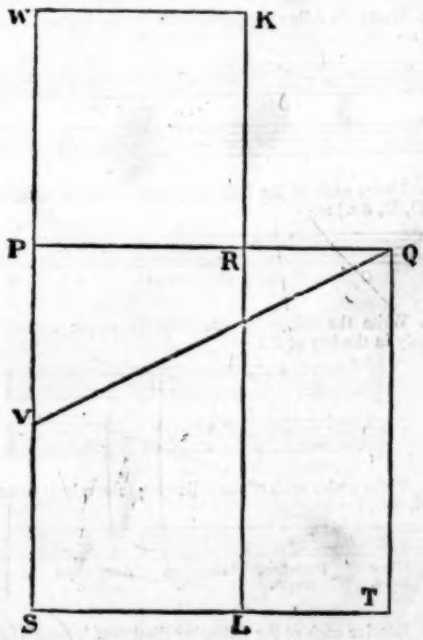
Let PQ be the given line.

On PQ describe a square (I. 46).

Bisect PS in V. Join VQ.

Produce PV to W, making VW=VQ (I. 3).

On WP describe a square PWKR, then R divides the line as required.

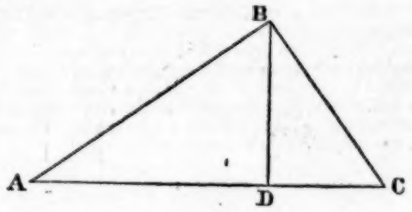


Because PS is bisected in V and produced to W.
Rect. SW, WP+sq. on PV=sq. on WV (II. 6).
Therefore sq. on VQ=rect. SW, WP+sq. on PV.

But sq. on VQ = sq. on PV + sq. on PQ.
Therefore rect. SW, WP = sq. on PQ.
But rect. SW, WP is the figure WL, since WP = WK.
And the sq. on PQ is the figure PT.
Take away the common part PL.
And WR = RT. That is the square on PR = rectangle made up of QT or PQ, and the part RQ.
The rectangle PL is the rectangle contained by PR, PQ, since PS = PQ, and RT = rect. PQ, QR = sq. on PR.
But PL + RT make up the figure PT, which is the sq. on PQ. Therefore sq. on PQ = rect. PQ, PR + sq. on PR.
Since PQ is divided in R, rect. PQ, PR = sq. on PR + rect. PR, RQ (II. 3).
But sq. on PR = rect. PQ, RQ (cons.).
Therefore rect. PQ, PR = rect. PQ, RQ + rect. PR, RQ.

12. In a right-angled triangle, if a perpendicular be drawn from the right angle to the base, the triangles on each side of it are similar to the whole triangle, and to one another. State and prove the corollary.

Let ABC be a right-angled triangle with perpendicular dropped from B to base AC.

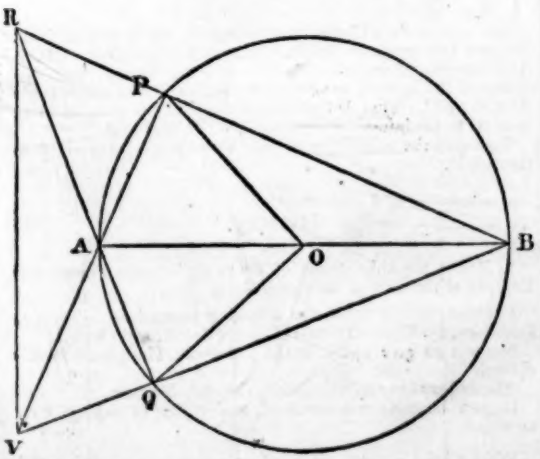


Angle ABC = BDA because both are right angles. Angle BAD is common to the two triangles ABD, ACB. Therefore the remaining angles ABD, BCA are equal. Therefore the triangle ABD is similar to ACB (VI. 4).

In the same way we may prove that BCD is similar to ACB. And therefore, since ABD, BCD are both similar to ABC, they are similar to each other.

Corollary.— The perpendicular BD is a mean proportional to AD, DC. And also AB is mean prop. to AC and AD, and BC is mean prop. to BC, DC.

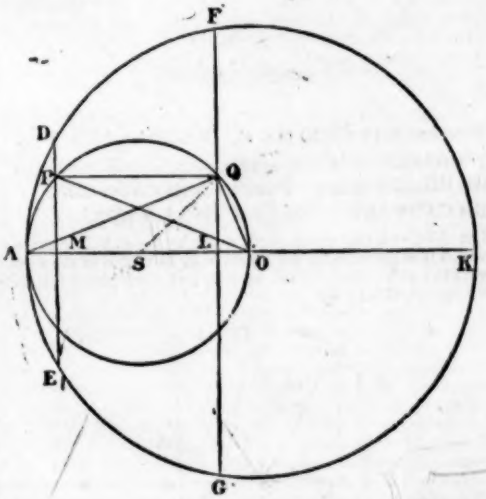
For in the triangles ADB, DBC, AD is to BD as BD to DC (VI. 4).
In the triangles ABC, ABD, AC is to AB as AB to AD.
" " ABC, DCB, AC is to BC as BC to DC.



AB is the diameter of a circle whose centre is O. Through O two radii OP, OQ, are drawn at right angles to each other, and on opposite sides of AB. AQ, BP meet at R, and AP, BQ meet at V. Show that the angle PVQ is half a right angle, and that if RV be joined the angle PO will be twice the angle PVR.

In the triangle PVB, the angle VPB is a right angle (III. 31). Therefore the angles PVB, PBV together make a right angle.
But PBV is half a right angle because it is half of POQ (III. 20). Therefore PVB is half a right angle, and is equal to PBV, and therefore also PB = PV.
In the same way we may prove ARB to be half a right angle.
Again, because RPA is a right-angled triangle, RPA being the right angle (III. 31).
And PRA being half a right angle (part 1).
Therefore PAR = PRA, and therefore RP = PA.
In the two right-angled triangles RPV BPV we have PV = PB (Part 1), RP = PA (part 2).
Therefore the triangles are equal in every respect (I. 4), and therefore RVP = PBA.
But POA is twice PBA (III. 18). Therefore also POA is twice PVR.

14. On OA the radius of one circle as diameter another is described, and a chord PQ is drawn in it parallel to OA. If through PQ lines be drawn perpendicular to OA, and meeting the larger circle in D, E and F, G respectively, then the sum of the rectangles contained by PD, PE and QE, QG is equal to the square on the radius of the larger circle.



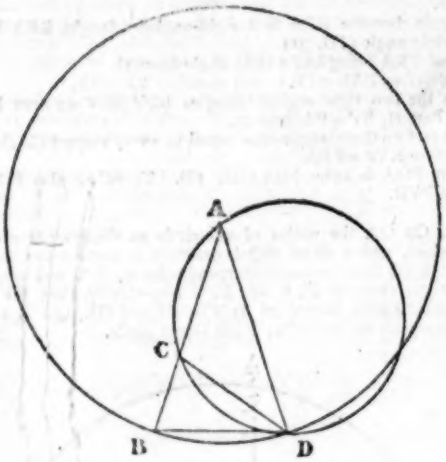
Sq. on FL = rect. FQ·QG + sq. on QL (II. 5).
Sq. on FL = rect. AL·LK (III. 35). Rect. AL·LK + sq. on LO = sq. on AO (II. 5).
∴ sq. on AO = rect. FQ·QG + sq. on QL + sq. on LO.
But sq. on LO + sq. on QL = sq. on QO (I. 47).
Therefore sq. on AO is greater than rect. FQ·QG by sq. on QO.
By an exactly similar process with DP, ME we can get that the sq. on AO is greater than rect. PD, PE by sq. on PO.
Therefore twice the sq. on AO is greater than rect. PD, PE + rect. FQ, QG by the sum of the sqs. on PO + QO.
But because PMQL is a rectangle + PM = QL, MS = SL (III. 14).
Therefore also AL = OM, and PM = QL, and the included angles are right angles, whence AQ = PO (I. 4).
But AQO is a right angle (III. 31).
Wherefore sq. on AQ (that is, sq. on PO) + sq. on QO = sq. on AO.
Therefore twice the sq. on AO is greater than rect. PD, PE + rect. FQ, QG by the sq. on AO.
Therefore the sq. on AO = rect. PD, PE + rect. FQ, QG.

To describe an isosceles triangle having each of the angles at the base double of the third angle.
Divide a right angle into 5 equal parts.
Draw any line AB and divide it at C so that sq. on AC = rect. AB, BC (II. 11).
Describe a circle with centre A radius AB.
Cut off BD in this circle = AC (IV. 1).
Describe a circle through ACD (IV. 5).
Join CD, AD. ABD is the required triangle sq. on BD (= AC) = rect. AB, BC.

Therefore BD touches the circle ACD (III. 37).

Therefore angle BDC=CAD. (III. 32). Add CDA to each of these.

Then BDA = CAD+CDA. But BCD = CAD + CDA (I. 16).



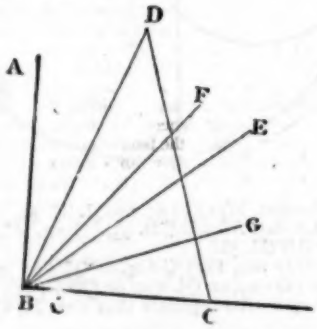
Therefore BDA=BCD (*ax.* 1). But BDA=ABD (I. 5).

Wherefore BCD=CBD, and therefore CD=BD (I. 6).

But BD=CA (cons.). Therefore angle CAD=CDA.

But CAD=BDC. Therefore CAD is half BDA.

Let ABC be the given right angle, and on BC describe an isosceles triangle with the angles at the base double of the vertical angle (IV. 10). Bisect DBC by EB, and then bisect DBE and EBC by FB, GB (I. 9).



Because DBC, BCD are each double of BDC, and the three angles are together equal to two right angles, DBC is two-fifths of two right angles, whence DBE, EBC are a fifth part of two right angles.

Therefore GBC, EBG, FBE, DBF are each one-fifth of a right angle, and therefore ABD is the remaining fifth.

The opposite angles of any quadrilateral figure inscribed in a circle are together equal to two right angles.

If the opposite angles of any quadrilateral be together equal to two right angles, show that a circle may be described round it, and find its centre.

Let ABCD be a quadrilateral inscribed in a circle.

Join BD, AC.

Angle ADB=ABC (III. 21).

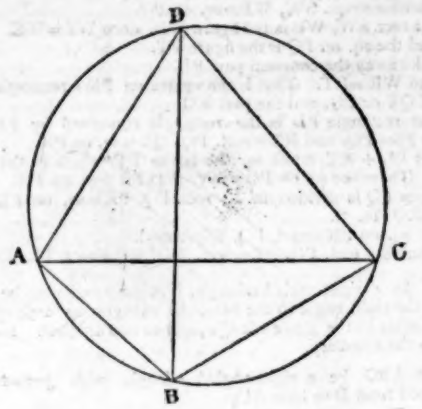
Angle DCA=DBA (III. 21).

Therefore angle DCB=ADB+DBA.

To each add DAB. Then DAB+DCB=ADB+DBA+DAB.

But ADB+DBA+DAB=two right angles.

Therefore DAB+DCB=two right angles.

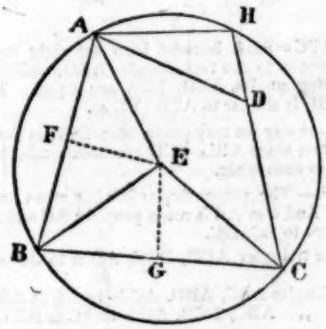


Let ABCD be a quadrilateral having ABC+ADC=Two right angles.

Bisect AB in F, and draw FE at right angles.

Bisect BC in G and draw GE at right angles.

So that FE, GE meet in E. Then a circle described with radius BE, centre E, will pass through AC. For AF=FB. FE is common; included angle is a right angle. Therefore AE =BE, similarly BE=EC.



And this circle will also pass through D, for if not, let it cut DC, or DC produced in H. Join AH. Therefore AHC+ ABC=two right angles.

But ADC + ABC = two right angles. Therefore angle ADC=AHC. That is the exterior angle of the triangle ADH is equal to the interior and opposite, which is absurd.

Therefore the circle cannot pass through H but must pass through D.

History.

1. Recite the chief terms of the treaty between France and England at the close of the Seven Years' War.

England was to retain the following possessions:—Tobago, Dominica, St. Vincent, Grenada, Nova Scotia, and Canada.

She was to give up St. Lucia, Cuba and Havannah, Pondicherry.

England was to receive Florida, Senegal, Minorca.

Certain boundaries were fixed, and rights of fishing, etc., arranged.

Write a brief account of Burgoyne's disastrous campaign and capitulation.

In 1777 General Burgoyne set out from Canada with a body of British troops to push across country and form a connection with the Hudson River, and so cut off the New England States from the others in rebellion. After some early successes he struck boldly out and engaged the Americans, under Generals Gage and

Arnold, at Stillwater, and, though victorious, suffered severely; the enemy, however, succeeded in cutting him off in the rear, and he soon found himself surrounded by a hostile and ever-increasing force. He entrenched himself at Saratoga, and vainly waited for help and relief. So closely did the enemy hem him in that he was unable to employ foraging parties, and at last, supplies failing, he capitulated, and, by the Convention, his troops were allowed to return to England, on condition of not taking any further part in the war.

Give some account of the critical condition of England financially, and as to foreign alliances in the years 1796-97.

The expense of carrying on the war with France was very great, and the Government had to draw very heavily on the Bank. At the same time, the fear of a French invasion led to money being held, and not invested, by persons who were fortunate enough to have it; the consequence of this was that the Government had to resort to paper-money, and it was some time before they were able again to pay in bullion.

England was deserted by Prussia and Spain, and then Spain soon after went over to the other side, while the French had also the Dutch as allies, so that England, single-handed, was opposed to all these nations.

Recite the chief provisions of the Act of Union, passed by the Irish Parliament in the year 1800.

(1) That Ireland should have 100 members in the House of Commons.

(2) Twenty-eight peers elected by their fellows to represent them in the House of Lords.

(3) That the Churches of England and Ireland should be united.

(4) And that both countries should have the same privileges of trade and justice.

Give some account of Lord Chatham's Ministry, 1766-1770.

On the failure of the Rockingham ministry, Chatham was induced to take office and form a Cabinet, including among others Grafton, Conway, and Townshend. But Pitt soon became seriously ill, or, at any rate, this was the cause stated for his withdrawal from public life, and the Ministry had to float on without him. Some of their Acts were the duties imposed on articles sent to the colonies, and the persecution of Wilkes. After two years' silence, Chatham reappeared, but by this time the Ministry had changed, Townshend had died, and the Grenville and Rockingham party were linked against him, Lord North was Chancellor of the Exchequer, and the opinions of the Government were no longer Chatham's opinions, and he consequently resigned office.

Who were the chief members of the Ministry of Rockingham? What were the chief difficulties they encountered at the outset?

The chief members of this ministry were the Duke of Newcastle, Grafton, Conway, and Edmund Burke.

They found themselves sadly puzzled how to act towards America; the Colony was in arms against the Stamp Act; Grenville and his party clamoured to have it enforced; Pitt called for its repeal, unconditionally, as being illegal.

The king supported Grenville's view, and a faction called the 'king's friends,' and whom Macaulay describes as a 'reptile body of politicians,' did their best to thwart the Ministry and support the monarch, and they thus had the full force of the opposition; and another body, who, holding Government offices and sinecure places, were counted as supporters, also against them. Besides this they had taken office with the support of the Duke of Cumberland, who had great influence; but soon afterwards he died, and they had among their number only one orator (who had his name to make), viz., Edmund Burke.

Detail the principal causes of the unexampled distress of the years 1816-17 in England.

There had been a very heavy strain on the country by the French war, which had drained men and money and spoilt trade. The Government had consequently had to increase taxes considerably.

To add to this there was a succession of bad harvests, and the importation of foreign corn was restricted by the Corn Bill of 1815. Thus bread was dear, money scarce, and trade bad, and the lower classes would suffer most by all this.

Prepare the outline of a lesson for an advanced class on one of the great measures of reform passed between 1828 and 1837.

REFORM BILL.

Ask who is member for the boys' town or county. How he becomes member, and who elects him, viz., householders or lodgers in boroughs, etc. Select some well-known town in their neighbourhood which has members and another has not; by naming several, draw out the general principle that the number of members depends on the population. Sketch the state of affairs before 1831, describing such places as Old Sarum and Gatton, and the consequent farce of election, also the rioting at elections and the small number of voters, and show the need of reform.

The Passing of the Bill.—Describe the course of the agitation; Lord Grey's Bill; its rejection; the riots at Nottingham, Bristol, aad Derby; the obstruction by peers; and the threat to create new peers; the final passing of the Bill.

Provisions.—Forty-four new boroughs, two members each. Let the boys try to name some of these by recalling the names of towns that have grown rapidly, as Birmingham, Manchester, London, etc. Twenty-one boroughs one member, more county members, several places disfranchised.

Describe the qualifications necessary for voters, and those added by this Bill, such as £10 householders in boroughs. Ask why the time of election should have been reduced, and why counties had two days and boroughs one day allowed. Compare with present time.

Recapitulate, and make complete blackboard sketch.

Composition.

Write in plain prose an essay on *one* of the following:—

(*a*) 'This was the noblest Roman of them all.'

(*b*) 'There is a tide in the affairs of man,
Which, taken at the flood, leads on to fortune:'

(*c*) 'Unto bad causes swear
Such creatures as men doubt.'

(*b*) A voyager embarking at a port would often find that though everything seemed in readiness for an immediate start, still the vessel waits and waits, and the captain watches the water until at last he seems satisfied, and gives the order to let go. If the traveller, impatient of the delay, inquired of a sailor the reason for the apparent waste of time, the answer would be, 'We're waiting for the tide, sir,' and further questioning would elicit the explanation that the vessel could only cross the harbour bar at the flood tide. This is evidently the kind of incident that was in Shakespeare's mind in writing the words that head this paper. In the scene where the words occur, Brutus and Cassius are consulting as to the future movements of their forces. Brutus urges immediate action and attack, Cassius suggests waiting for the enemy's onslaught, when the former replies that their cause is ripe, their friends are all with them, and that future delay will only be running the risk of desertion, and this view he urges with the speech, 'There is a tide, etc.'

Most men in reviewing their life can look back on some period when their mode of action has led, either to continued after success, or, on the other hand, to years of failure or mediocrity.

Who in reading the life of Lord Beaconsfield can help admiring the tact of the man in seizing the opportunity of Sir R. Peel's acceptance of the Anti-Corn Law League, to combine his fortunes with those of the disappointed Tories, and abuse their once-admired leader; and many other noted men have attained their eminent position mainly by means of the clear foresight that has led them to embark on their enterprises at the critical period which would command success.

Grammar.

Paraphrase the following passages, and comment briefly upon the words italicised:

Vexed I am
Of late with passions of some *difference*,
Conception only proper to myself.
Which give some soil perhaps to my behaviours.

'Tis a common proof,
That lowliness is young ambition's ladder,
Whereto the climber-upwards turns his face,
But, when he once attains the upmost round,
He then unto the ladder turns his back,

Looks in the clouds, scorning the base *degrees*
By which he did ascend.

Swear priests and cowards and men *cautelous*
Old feeble *carrions* and such suffering souls
That welcome wrongs; unto bad causes swear
Such creatures as men doubt; but do not stain
The even virtue of our enterprise,
Nor the insuppressive mettle of our spirits,
To think that or our cause or our performance
Did need an oath.

These *couchings* and these lowly courtesies
Might fire the blood of ordinary men
And turn *pre-ordinance* and first decree
Into the law of children. Be not *fond*
To think that Cæsar bears such rebel blood
That will be thaw'd from the true quality
Like that which melteth fools.

I have lately been sorely perplexed by contending emotions and with thoughts which concern me alone, and which somewhat sully and spoil my demeanour towards others.

It has very often occurred to me that humility is like a ladder which assists a man to rise. While climbing he turns his face towards it, but when once he has attained the desired eminence he turns round, no longer caring for those steps that helped his ascent, but viewing the wide expanse of heaven.

Priests and cravens, deceitful men, and faint-minded old persons are those from whom you should require an oath, and from those who delight in wrong-doing. Oaths are needed when the cause is bad, and when the performers of the act are untrustworthy; but our cause is not of this class, and we should only tarnish the moral excellence of our undertaking, and our strength of purpose by supposing that either need an oath to bind them.

All this stooping and prostration might puff up some men with pride, and cause them to alter their previous decisions with the captiousness of children. Do not be so foolish as to think that Cæsar's blood is so easily inflamed as to lead him astray in his actions.

Difference—that are in conflict one with another.
degrees—the steps or rungs of the ladder.
cautelous—crafty or cautious, first meant cautious, then suspicious, then crafty or deceitful.
carrions—carcases, used contemptuously.
couchings—stoopings, prostrations, to 'couch' is to stoop or bend low.
pre-ordinance—things decreed from the beginning.
fond—foolish, still used in the north part of England with this meaning.

Explain the ides of March—I had as lief not be—the cross blue lightning—no fleering tell-tale—richest alchemy—the genius and the mortal instruments—the eighth hour—wilt thou lift up Olympus?—signed in thy spoil—cry 'Havoc'—Cæsar's angel—abjects, orts, and imitations.

The ides of March.—The 13th of some months and the 15th of others was called 'the ides.' The ides of March would be the 15th.
I had as lief not be—I would as willingly not exist.
The *cross* blue lightning—the zigzag path of the lightning.
No fleering tell-tale—no grinning or sneering sneak.
Richest alchemy.—Alchemy professed to change base metal into gold.
Genius and the mortal instruments—the soul and the bodily powers.
Wilt thou lift up Olympus?—Olympus, a mountain in Greece. The question is asked to imply, Wilt thou try to do an impossible thing?
Signed in thy spoil—linked together at thy capture.
Cry 'Havoc'—raise a cry of slaughter without giving any quarter.
Cæsar's angel—was like his guardian angel, so inseparable was he from him.
Abjects, orts, and imitations—castaway pieces, odds and ends, and mocking others.

Show the truthfulness of the following lines:—

Yon grey lines
That fret the clouds are messengers of day.

I am constant as the northern star.

Hollow men, like horses hot at hand,
Make gallant show and promise of their mettle.

In watching a sunrise, the even dulness of the sky would be observed to change, and a few lines break the clouds, then gradually spreading and changing colours.

The northern or pole star is said to be the centre of the heavenly systems, and our axis points to it, hence it never changes its position in the heavens.

Those horses that prance much and are restless are often thought to be splendid animals, and seem to be only too eager to perform great feats. So with hypocritical persons; they promise much, but perform but little of it.

Point out any grammatical peculiarity in the following:—

I'll about.—A verb of motion (as turn) omitted before an adverb or preposition, common in Shakespeare.
Be not jealous on me.—'On' used for 'of.'
What need we any spur.—'What' for 'why.'
And that were much he shall.—'Much' means 'hard,' and that is put before 'were.'
Let no man abide this deed but we the doers.—'Abide' is used transitively, as in 'I cannot abide it,' and 'we' is subject of 'will abide it,' which is understood.
There is tears for his love.—'Tears' plural and 'is' singular. 'Tears is there.'
Ay, and truly you were best—i.e., 'it were best for you.' The objective pronoun put before the verb.
As the flint bears fire who shows a hasty spark.—'Who, which we use only for person, here refers back to a neuter thing, 'fire.' 'We should say 'that' or 'which.'
Only I yield to die.—The place of the adverb 'only' changed from behind the verb to before the subject.

Write an analysis of the Essay on Study, explain and illustrate from your own reading, books to be 'read by deputy,' to be 'swallowed,' and the best cure for 'wandering wits.'

Studies are for delight, ornament, and improvement of mind or intellect.

Too much study is idleness and laziness.
Used too much for ornament is affectation.
To judge solely by, and depend entirely on, weakness.
They must be linked with and controlled by experience.
Read to weigh and consider.
Some books read—
(1) Only in part.
(2) Others scanned through.
(3) Others wholly and carefully.
(4) Others by deputy.
Reading makes a full man.
Writing an exact man.
Conversation a ready man.
Different studies serve different purposes.
As Mathematics—to give power of concentration.
History—a knowledge of the ways of the world.
Logic and Rhetoric—argumentative power.

Books 'to be swallowed,' such as novels, descriptions of historical characters, or adventures, give one a general knowledge, but would be waste of time to study carefully every detail.

'Read by deputy.' Large volumes, such as Mill's 'Political Economy,' or Hamilton's 'Mental Philosophy,' which are too compendious for students in college to wade through, but if read by the tutors, and abstracts given of the parts most useful to them, the abstracts would be of great value.

Best cure for 'wandering wits.' Mathematics. It is no use trying in a half-hearted style to study Euclid, for instance; for if we let our wits wander, and once drop the thread of the demonstration it is necessary to begin all over again.

Name some of the 'false points of praise'; and point out how praise may be judiciously employed.

False points of Praise—When it is only flattery or praising to one's hurt, maliciously, either to him, and so cause him to be conceited, or to others to excite jealousy. Over-praising one.
Judicious use of Praise—If a boy has done a difficult task, praise will be a reward to him, and stimulate him to further effort. If the praise be public, others will also be excited to emulation.

State briefly the antithesis between the conduct of the young and the old, suggested in Bacon's essay on 'Youth and Age.'

Youth.	Age.
Quick in invention and imagination.	Slow, but sure.
Good at carrying out new projects, or acting under fresh circumstances.	Better in counselling things already known than in adapting to new circumstances.
Err through rashness.	Fail in not acting quickly enough.
Undertake more than they can fulfil.	Consult too long, object too much, and are too careful of not adventuring money where it may be lost.
Do not wait to calculate ways and means.	Are governed by the power of understanding.
Act by impulse of will and affections.	

—o—

The Discipline of the Mind.

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VI.—The Will and its Training—*(continued).*

Much of the war of words that has been waged in respect of this question of the nature and extent of Will would have been rendered unnecessary, if it had been always understood that pleasure and pain are, in strict language, not 'motives' at all, except in relation to a character. Exaggerated stress laid upon the external factor, the represented pleasure and pain, has led to human beings being considered the creatures of circumstance; an excessive attention to the internal factor has given rise to the idea of a metempirical entity, playing at times the part of a *deus ex machina* by interfering with the psychical mechanism, a pure potency whose reality and actuality are far from being synonymous. It is here maintained that it is impossible (except logically) to separate will and manifestation of will, and that what we have to consider is the quite definite relation of the active side of mind to feeling. Frequently, it must be said, the feelings are of a very subtle and concealed kind, so that they do not form portions of distinct consciousness, and somewhat of the mystery that has hung round these voluntary processes is doubtless due to this circumstance; for it is by no means always possible to peer into the dark laboratory where the forces of the mind are elaborating in silence their marvellous products. But however obscure the subject always in detail remains, we know sufficient of the process now to clearly formulate the problem, and can always translate the fictitious abstractions of the schools into the language of concrete consciousness. We shall not be disturbed, *e.g.*, by associations of a metaphysical nature that have gathered round such a term as that of 'choice,' for instance. We shall regard it as a short expression for the fact that any particular resolution is chiefly dependent upon the internal factor, the spiritual fabric, which, although known in the main, will, in large part, always be unknown until revealed at the moment of action. The *selection* is due to that which is somewhat vaguely styled 'the character,' which in part resembles, and in part is unlike, that of other individuals. This character is liable to modification, and hence the 'choice' may vary with the very same persons with the very same motives, for between the two occasions of choosing the individual may have been submitted to influences which render the situation a different one. Room is therefore found at this point for the part of the educator, and we accordingly pass to the consideration of the Training of the Will.

Let the nature of the problem be quite understood. Given human minds with certain susceptibilities and propensities, how to induce the adoption of a particular line of conduct. The methods will be different to some extent according to the numbers attempted to be influenced. An orator in dealing with a vast multitude can only appeal to the broadest principles of human nature. He must consider the multitude before him as a single plain individual, a being simplified to the mental and moral structure possessed by the average of mankind, and therefore not below the level of the time or much above it. In the same way the disciplinarian in dealing with a large body of youths; average juvenile nature must be assumed, and the discipline must be calculated for the average. But it is the same thing whether we deal with the average of a large number or the mean stratum of the nature of any one individual; and hence we may assume in all discipline of the will that certain motives will influence all alike. The *appetites* are common to all. The instinctive cravings which have reference to the life-preserving functions can be taken for granted as uniformly strong. Now the satisfaction of these primordial cravings up to a certain limit is essential for healthy existence, and the only danger here is of undue interference. As a rule, it may be taken for granted that the child knows its own wants best when these wants have reference to self-preservation. But there is, of course, a dubious margin; and for this reason, that a gratified appetite is wont to make its appearance hereafter in the guise of desire. A desire is a state of mind wherein we are subject to the fascination of some pleasure, now ideal, whose sweetness we have already tasted in the reality. Now as the gratification of all appetites is attended with pleasure, it is quite possible for the pleasure to become a distinct object to the mind, and for the craving to arise when there is no real need of the system. Besides the appetites, whose gratification is essential for healthy existence, there are secondary desires due to a certain way of living, a certain social environment, to anything, in short, which continued for a sufficient time comes to be craved so ardently that its absence is keenly felt. It is not always, indeed, easy to discriminate, especially in an advanced stage of civilisation, between those cravings which are of the essence, as one might say, of our being, and those recurring needs which have come to be a part of our ordinary life-routine. Directly, however, pleasure becomes an object for its own sake, we get an effective leverage for controlling the will. But the difficulty of the case is this, that, save in the case of the absolute needs of the constitution, the susceptibility varies so much that a very different discipline is necessary in some cases than in others. Next to primary appetite I think one might say that *sociality* is the strongest of all cravings. Of all modes of punishment at least absolute solitary confinement has always been recognised as the most painful, and resort to even a small measure of it should be very sparingly exercised. As we must not yet enter, however, upon the general subject of moral education, but confine ourselves to the psychology of the will, we must be content with the foregoing illustrations of the endeavour to force an association between a certain course of conduct and consequent pain or pleasure. Of the two species of association the latter is by far the more desirable, but it cannot be said that it is the more forcible. There

is no mind, indeed, so fortunate in its constitution as to be guided by the lure of pleasure alone, and hence the one application of pain becomes the gravest of problems. There is, indeed, a self-rectifying power in both disciplines, for pleasure grasped in excess passes into pain, and pain applied beyond a certain point renders the nature obtuse and insensitive.

The end to be achieved in the discipline of the will is to raise a pleasure or pain *in idea* to the intensity of a pain or pleasure in reality, to make the individual act as he would act if the solicitation were there in all the urgency of a present feeling. It will be obvious that the most imaginative mind has the best chance of conforming his conduct aright without any extraneous aid in the shape of rewards and punishments. And undoubtedly it is so; only imagination may be strong or weak in relation to quite different things. But even so guarded, the remark will not be true unless along with the imagination can be the conviction of realisation. Now there is not always this co-existence between a vivid imagination and belief. We may very vividly depict all the harmful consequences of some indulgence, and yet have a secret hope that such consequences may be in some way averted. It is the characteristic of a normal mind to adjust its action to the probabilities of the prospective pains and pleasures. It is the mark of an unsound mind to see the better, and yet follow the worse, to be so possessed by an idea as to seek fruition utterly regardless of consequences. When action is not capable of being proportioned to motive the will is paralysed, and what training is possible must have for object the restoration of the physical or mental balance. But, if there be no derangement of the volitional mechanism, the processes available for attaining that self-mastery which lies at the foundation of all progress are the following.

As thoughts and feelings come and go according to purely natural law, it is frequently necessary to interfere with the current succession, and to turn into other channels, or wholly to subdue the energy of emotion. To accomplish these ends it is indispensable to acquire a habit of attention. We must gain the power of singling out certain less conspicuous portions of the train of thoughts, letting all else go, and dwelling upon the chosen objects until they occupy the whole field of consciousness. The lesson may be begun in the simplest act of observation, where the natural tendency to dwell on more striking objects is thwarted, and the gaze is concentrated on uninteresting details. So important is the acquisition of this power in the development of the will, that it is often the only weapon at our disposal for gaining the victory in the warfare of the inner life. The importance of it may be imagined when we reflect that the intellectual rains are always at the mercy of chance suggestions, hat there is no guarantee for correct associations eing formed in the haphazard conjunctions of rdinary experience. The firmest associations may in this way get formed before any selective power has been exercised.

The emotions exert their influence either directly in the shape of powerful, spontaneous impulses, or indirectly through association with some special ideas. The waves of feeling, never wholly insignificant, sometimes gather an unexpected strength, the causes being wholly unconscious, or an idea may leap into life in consequence of some casual suggestion. To subdue our emotions directly by sheer force of will is impossible. The most effective course is to play one off against another. It is, indeed, a misuse of language to describe will as a source of energy; the office of the will is directive. The energy of the system is supplied by feeling. The control of any feeling, then, is either by releasing the springs of a contrary feeling, as when hate is quenched by love, or by diverting the emotional stream, by fixing the attention on thoughts that are linked with other more desirable feelings. The difference between the man of weak and of strong will lies in this, that the former allows himself to be at the mercy of the passing thought or transient emotion; the latter allows the thought of injurious consequences to act as a new motive, in addition to the present impelling forces. We have, at opposite ends of the volitional scale, the amiable yielding temperament, which gives up at the first assault, whose actions cannot be calculated upon, and the hard, unbending character to which the bare love of power ranks as sole motive. Where the one is self-destructive, by allowing its strength to be undermined, the other crushes, not controls the sensuous nature, and seals up the fountains of emotion. The desirable temperament is flexible without being weakly concessive, attains its ends with a due regard to changing circumstances. It requires a nice tact to know when to yield to the pressure of feeling, when to call up the opposing force of a permanent ideal. Man is not to be the sport of blind nature, but to be a law to himself. He has to rise out of the Fate of Nature, but in obedience to certain norms that are impersonal, which are valid not only for himself, but for all men. Self-control does not mean self-assertion. It means giving that weight to the various impulses which is their due as part of a well-ordered system.

To return, then, to our method of self-control. Its conditions and limits are well-defined. As volition means action determined by feeling (the only motor-feelings being pleasures and pains), a rightly directed volition signifies action not according to what we do feel, but according to what we should feel. Any instance of acquired self-command will illustrate the process. To be simply borne along by an impulse may be highly pleasurable, to follow some favourite pursuit, to read some enticing book (the opening for the training of the youthful will is usually afforded by such an instance); but a foresight of remote consequences reveals the greater worth of another course of conduct, for the moment painful, but productive of a more lasting pleasure, say the mastering of a scientific treatise. Only a highly-developed intelligence can be expected to vividly realise the advantages of such a course of action, and the strength of the motive-power must be increased by the coercive discipline of pain for neglect, that is by making the following the present impulse less pleasurable than performance of the prescribed task. But no educator will be satisfied by a merely coercive policy. Enforced obedience may engender habit, but habit thus produced is apt to degenerate into slavery. The last stage of the educational process consists in the calling into play one supreme motive, *pleasure in the exercise of original power*. When an end aimed at is accepted as our own end, then for the first time is the action rightly described as freely chosen or pre-eminently voluntary.

In the education of the will two things are especially to be kept in view. The one is, that progress must at

first be very gradual. The control of thought, the direction of feeling, cannot proceed beyond a certain pace. To ask for much self-denial at the outset is to be utterly unreasonable. The other is, that each success is to be regarded as a *plus*, every failure as a *minus* quantity. Each victory over present inclination for the sake of a more distant good makes, quite independently of the law of habit, the chance of a second victory easier by giving a new motive, viz., the memory of a victory achieved, and therefore adds a fresh stimulus to exertion. On the other hand the memory of failure is an obstructive force; the second attempt will be more arduous than the first, the natural inertia of the system being reinforced by a certain amount of belief that voluntary effort itself is vain. Hence the egregious folly of requiring efforts beyond the individual strength. Unless there is a probable certainty of success the will should not be called upon; an easier task must first be attempted; the inexperienced warrior must win his spurs on a less dangerous field.

(To be continued.)

—o—

Recent Inspection Questions.

[*The Editor respectfully solicits contributions—all of which will be regarded as* STRICTLY PRIVATE—*to this column. For obvious reasons, it cannot be stated in which district the questions have been set.*]

Arithmetic.

STANDARD II.

(1) 33,880 × 78. Ans. 2,642,640.
(2) 50,904 ÷ 9. Ans. 5,656.
(3) 76,372 − 49,080. Ans. 27,292.
(4) 13,865 × 309. Ans. 4,284,285.
(5) 71,016 ÷ 8. Ans. 8,877.
(6) 74,986 − 29,308. Ans. 45,678.

STANDARD III.

(1) A girl had 11s. in her pocket. Her brother gave her 5s.; he then had 8s. left. How much more, at first, had he than his sister? Ans. 2s.

(2) A man was born in 1569 and he died in 1670. Another man born in the same year died in 1680. How much was one older than the other?
Ans. 10 yrs.

(3) What number multiplied by 747 will bring the same answer as 87 multiplied by 249? Ans. 29.

(4) What number multiplied by 747 will bring the same answer as 27,380 − 13,934? Ans. 18.

STANDARD IV.

(1) If 10 pennies standing one upon another measure an inch, how much money is there in 100 heaps standing 4 feet high? Ans. £200.

(2) How many inches in 2 miles 20 yds.?
Ans. 127,440.

(3) 60 ac. 4 rds. 14 per. 19 yds. to feet.
Ans. 2,661,142½ ft.

(4) £312 15s. 9d. ÷ 508.
Ans. £0 12s. 3¾d. + 48

(5) A field is 1000 acres. How many acres are there in 110 fields? Ans. 110,000.

(6) If a man's income is £50 per quarter year, and he spends 8s. a week, what does he save?
Ans. £179 4s. 0d.

(7) £4,763 18s. 9d. × 5,010.
Ans. £23,867,326 17s. 6d.

(8) A forest of 5,024 acres was cut into fields, each containing 110 yds. How many fields were there?
Ans. 221,056.

[N.B.—The fields are each less than an ordinary village school-room;—exquisitely ridiculous.—ED. of P. T.]

(9) A sum of money was distributed among 97 men and 87 women; each man got £1, 3 shillings, 2 half-crowns, and 5 sixpences; each woman got half as much as a man. What was the amount of money?
Ans. £214 5s. 3d.

STANDARD V.

(1) $\frac{3}{5}+\frac{1}{7}+\frac{9}{10}$. Ans. $1\frac{9}{14}$.

(2) If I walk 120 yds. in 1 minute, how long will it take to go 3 miles? Ans. 44 min.

(3) A farmer pays a ¼d. rent for every square yard of his farm. His whole rent is £363. Find the size of the farm in acres. Ans. 72 acres.

(4)

17 lbs. at 2½d. per lb.	£0	3	6½
5½ lbs. at 1s. 6d. per lb.	0	8	3
7 lbs. at 2s. 6d. per lb.	0	17	6
5 tins, each containing 17 lbs. at 7d. per lb.	2	9	7
Ans.	£3	18	10½

(5) 676 articles at £7 18s. 10½d. each.
Ans. £536 19s. 6d.

(6) $\frac{1}{2}+\frac{3}{4}+\frac{1}{8}+\frac{7}{16}$. Ans. $2\frac{7}{16}$.

(7) Find the value of 6 cases each containing 17 cwt. 2 qrs. 21 lbs. at £2 14s. 0d. per ton.
Ans. £14 6s. $6\frac{8}{20}$d.

(8) 4 men dig a drain 69 yds. long in 42 days; how long will it take 10 men to dig the same drain?
Ans. 16⅘ dys.

N.B. Mental Arithmetic taken throughout. Not severe.

Grammar.

STANDARD II.

To underline nouns and verbs in dictation.

STANDARD III.

Each scholar to pick out one part of speech from dictation.

STANDARD IV.

Parse:—
(*a*) The bear lives near the sea
(*b*) For he likes to swim in the water.

STANDARD V.

Analyse and parse:—
(*a*) By-and-by up comes the round head of the seal.
(*b*) Sometimes he dives into the water after a fish.

Dictation.

All the dictation was taken from the 'Royal Readers.'

STANDARD II.

(*a*) Page 95.—'There was.....before him.'
(*b*) Page 101.—'The lion.....in Asia.'

STANDARD III.

(*a*) Page 101.—'When he reached.....same time.'
(*b*) Page 99.—'The butler .....best policy.'

STANDARD IV.

(*a*) Page 68.—'A Swiss hunter.....down the cliff.'
(*b*) Page 68.—'Chamois hunting.....their escape.'

Reading and Recitation.

In Standards II., III, and IV., the 'Royal Historical Readers' and 'Royal Geographical Readers' were used, each being read alternately.

In Standard V., 'Robinson Crusoe.'

The repetition was severe throughout.

Geography.

STANDARD II.

Name the oceans. Name the continents. Point to each. What is an island? Point to and name islands on the map of world. What is a lake? Point to one in England. What is a peninsula? Point to one in England. What is a bay? Point to one on the map.

STANDARD III.

Relative positions of counties in South of England—boundaries—islands in mouth of Thames—capes—bays—islands off south coast—towns in south counties.

STANDARD IV.

Name islands north of Scotland which are nearest to Scotland—islands on west. How many groups? Largest of outer Hebrides—a town on it. Largest of inner group. What do we get from Skye? What separates the two groups? River on the west of Scotland. Chief town on the Tay—what noted for? What town is a port for whale fishers? Town near Firth of Forth—what is its port? What is Dunfermline noted for? What is Paisley noted for? Town on Clyde? What is Aberdeen noted for?

Where is St. John's? British North America? What is between Erie and Ontario? How far do they fall? Where is Newfoundland? New Brunswick? What is the Fraser River noted for? Rivers flowing north? Where is Halifax? Manitoba? Rocky Mountains? Vancouver Isle?

(Inspector asked children to point out places on the map.)

Publications Received.

Bell (G.) and Sons—
Sallusti; Catilina et Jugurtha. By G. Longman.

Blackie and Son—
Robinson Crusoe.
Readings from Sir Walter Scott, with Notes.
Adventures in Field, Flood, and Forest.
The Pirate Island. By Harry Collingwood.
Brothers in Arms. By F. Bayford Harrison.
Stories of the Sea in Former Days.

Chambers (W. and R.)—
Elementary Hygiene. By T. London.

Davies (H. G.)—
The Queen and Her Relations (a genealogical table).

Fisher Unwin (T.)—
Easy Lessons in Botany. By E. Step.
First Natural History Reader.
Heroic Adventure.
Plant Life. By E. Step.

Heywood (John)—
Analysis of the Book of Judges. By Lewis Hughes, M.A., and the Rev. T. Boston Johnstone.

Hodder and Stoughton—
Meg's Mistake. By Mrs. R. O'Reilly.
A Long Lane with a Turning. By Sarah Doudney.
Just in Time. By Mrs. G. S. Reaney.
The Orient Boys.
The Autocrat of the Nursery. By L. T. Meade.

Jakeman and Carver—
The Oxford and Cambridge French Reader. By Frédéric Hunt.

Jarrold and Sons—
Geography. Standards I. to VII.
Arithmetic. Standards I. to VII., and Answers.
Summary of English History.
} Young England School Series.

Johnston (A.)—
Johnston's Object Lesson Pictures for Schools. Fruit Trees:—Olive, Peach, Bread Fruit, Vine, Fig, Pomegranate.

Kegan Paul and Co.—
Higher Education in Germany and England. By C. Bird.

Longmans and Co.—
Virgil's Æneid. Book XII. (Dr. White's Grammar School Texts.)
Longman's Magazine. October.
The Elements of Music. By F. Davenport.
Key to the Art of Solving Problems in Higher Arithmetic. By Rev. J. Hunter, M.A.

Miscellaneous—
The Cornhill Magazine. October. (Smith, Elder and Co.)
A Catalogue of the Japanese Exhibits at the Health Exhibition. (W. Clowes and Sons, Limited.)
Letts's Illustrated Household Magazine for October.

Maclehose (J.) and Sons—
German Grammar. By Clemens Schlomka, M.A., Ph.D.

Murby (T.)—
Algebra for Beginners. Stages I., II. and III. By W. Dodds.
Langton's Examples in Arithmetic. Standard VII.

Nelson (T.) and Sons—
The World at Home. Standard VI.

Nisbet (J.) and Co.—
Lays and Ballads of Heroism. By H. J. Barker.

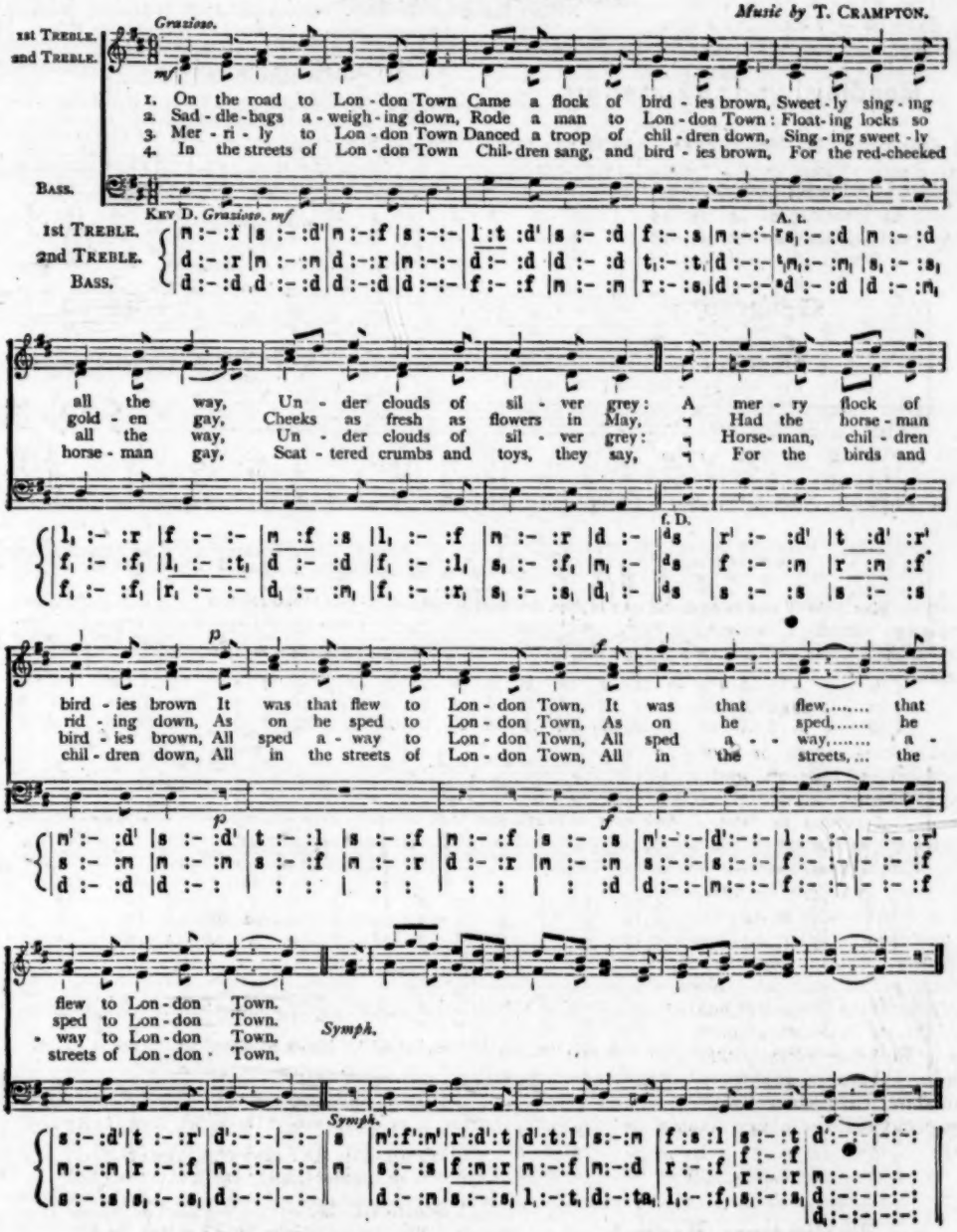
Robertson (G.) and Co., Limited—
Grammar and Logic. By J. W. F. Rogers.

Stanford (E.)—
The London Geographical Reader. Book V.

The Oxford University Press—
The Church of England Sunday Service Book.

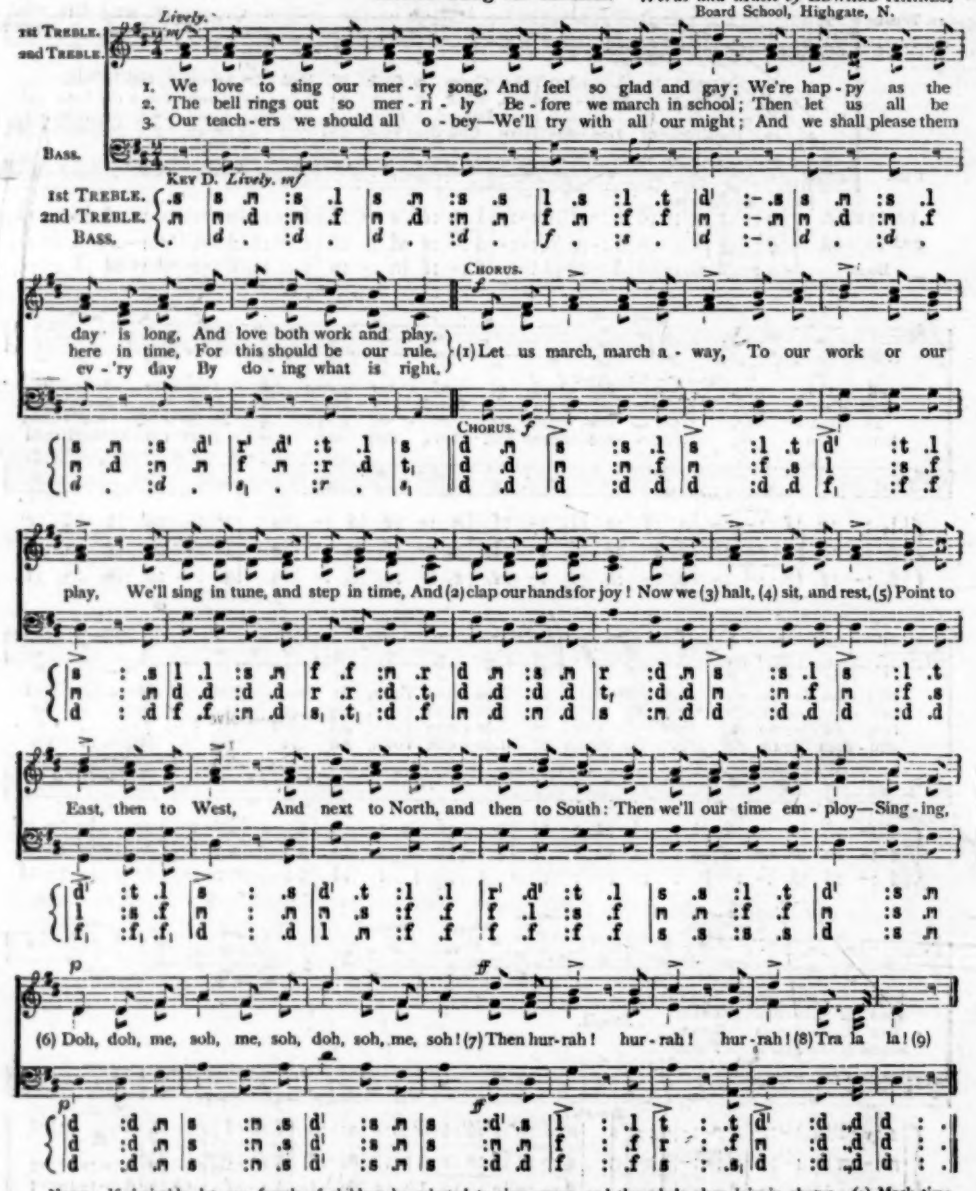
ERRATA.—In October number of PRACTICAL TEACHER, on page 361, for £129 *read* £112 17s. 6d., and for £146 5s. *read* £135. On page 360, for 3 *read* $3\frac{1}{1}$.

LONDON TOWN.

Music by T. CRAMPTON.

Gracioso.
1st TREBLE.
2nd TREBLE.
BASS.
mf
1. On the road to Lon-don Town Came a flock of bird-ies brown, Sweet-ly sing-ing
2. Sad-dle-bags a-weigh-ing down, Rode a man to Lon-don Town: Float-ing locks so
3. Mer-ri-ly to Lon-don Town Danced a troop of chil-dren down, Sing-ing sweet-ly
4. In the streets of Lon-don Town Chil-dren sang, and bird-ies brown, For the red-cheeked
Key D. Gracioso. mf
A. L.
all the way, Un-der clouds of sil-ver grey: A mer-ry flock of
gold-en gay, Cheeks as fresh as flowers in May, Had the horse-man
all the way, Un-der clouds of sil-ver grey: Horse-man, chil-dren
horse-man gay, Scat-tered crumbs and toys, they say, For the birds and
f. D.
p
f
bird-ies brown It was that flew to Lon-don Town, It was that flew,..... that
rid-ing down, As on he sped to Lon-don Town, As on he sped,..... he
bird-ies brown, All sped a-way to Lon-don Town, All sped a-way,..... a-
chil-dren down, All in the streets of Lon-don Town, All in the streets,... the
p
f
flew to Lon-don Town.
sped to Lon-don Town.
-way to Lon-don Town.
streets of Lon-don Town.
Symph.
Symph.

"The Practical Teacher" Music Competition—Second Prize (Action Songs).

WE LOVE TO SING OUR MERRY SONG.

Action Song for Infants. *Words and Music by* EDWARD HAINES, Board School, Highgate, N.

Lively.
1st Treble.
2nd Treble.
Bass.
1. We love to sing our mer - ry song, And feel so glad and gay; We're hap - py as the
2. The bell rings out so mer - ri - ly Be - fore we march in school; Then let us all be
3. Our teach - ers we should all o - bey—We'll try with all our might; And we shall please them
Key D. Lively. mf
Chorus.
day is long, And love both work and play.
here in time, For this should be our rule,
ev - 'ry day By do - ing what is right.
(1) Let us march, march a - way, To our work or our
play, We'll sing in tune, and step in time, And (2) clap our hands for joy! Now we (3) halt, (4) sit, and rest, (5) Point to
East, then to West, And next to North, and then to South: Then we'll our time em - ploy—Sing - ing,
(6) Doh, doh, me, soh, me, soh, doh, soh, me, soh! (7) Then hur - rah! hur - rah! hur - rah! (8) Tra la la! (9)

NOTE.—If desirable, let one fourth of children be selected to sing verses, and the whole class join in chorus.—(1) Mark time. (2) Clap also. (3) Cease marching and clapping. (4) Sit. (5) Point in direction indicated. (6) Class beat time with forefinger on palm of left hand. (7) Rise, wave the arm above the head, and deliver the hurrahs with enthusiasm. (8) Clap to time. (9) After last verse add quick clapping, similar to ordinary applause.

Query Column.

RULES.

1. Each correspondent is restricted to *one question*. We should be much obliged if correspondents, who send questions for solution, would give (if possible) the required answer, and the source from which the question is obtained.

2. No query can be answered unless accompanied by the real name and address of the sender, not necessarily for publication, but as a guarantee of good faith and for facility of reference.

3. ☞ When a pseudonym is adopted it should be written at the end of the query, and the real name and address on a separate piece of paper.

4. Correspondents are requested to write their queries *legibly*, and on one side of the paper only.

5. Replies will not be sent through the post.

6. Queries must reach the office *not later than the 12th of the month*, or they cannot be attended to in the following issue.

*** All communications for this column should be addressed—'*The Query Editor*,' *The Practical Teacher*, *Pilgrim Street, Ludgate Hill, London, E.C.*

Algebra.

1. WELSHMAN.—Prove that
$$4xy(x^2+y^2)=(x^2+xy-y^2)^2-(x^2-xy+y^2)^2.$$
(*Todhunter.*)

$$(x^2+xy+y^2)^2-(x^2-xy+y^2)^2$$
$$=x^4+x^2y^2+y^4+2x^3y+2x^2y^2+2xy^3$$
$$-(x^4+x^2y^2+y^4-2x^3y+2x^2y^2-2xy^3)$$
$$=x^4+x^2y^2+y^4+2x^3y+2x^2y^2+2xy^3-x^4-x^2y^2-y^4+2x^3y$$
$$-2x^2y^2+2xy^3$$
$$=4x^3y+4xy^3$$
$$=\underline{4xy(x^2+y^2)}.$$

2. G. T. D.—In the Quadratic Equation $x^2+ax+b=0$ show that $-a$ = the sum of the roots.

Solve the equation $2x+\sqrt{x^2+7x+23}-25=0$. (*Scholarship.*)

$$x^2+ax+b=0$$
$$x^2+ax=-b$$
$$x^2+ax+\left(\frac{a}{2}\right)^2=\frac{a^2}{4}-b$$
$$=\frac{a^2-4b}{4}$$
$$x+\frac{a}{2}=\frac{\pm\sqrt{a^2-4b}}{2}$$
$$\therefore x=\frac{\pm\sqrt{a^2-4b}-a}{2}.$$
$$\therefore \text{Sum of roots}=\frac{\sqrt{a^2-4b}-a}{2}+\frac{-\sqrt{a^2-4b}-a}{2}$$
$$=\frac{-2a}{2}$$
$$=\underline{-a}.$$

$$2x+\sqrt{x^2+7x+23}-25=0$$
$$\sqrt{x^2+7x+23}=25-2x$$
$$x^2+7x+23=625-100x+4x^2$$
$$x^2-4x^2+7x+100x=625-23$$
$$-3x^2+107x=602$$
$$x^2-\frac{107x}{3}=-2\tfrac{2}{3}^2$$
$$x^2-\frac{107x}{3}+(3\tfrac{5}{6}^7)^2=11\tfrac{44}{36}^9-5\tfrac{1}{3}^2$$
$$=\frac{11449-7224}{36}$$
$$=4\tfrac{3}{3}\tfrac{1}{6}^{2}$$
$$x-1\tfrac{7}{6}^1=\pm\tfrac{5}{6}^5$$
$$x=\pm\tfrac{5}{6}^5+3\tfrac{7}{6}^1$$
$$\therefore x=7, \text{ or } \tfrac{5}{3}^5.$$

The value $\frac{5}{3}^5$ does *not* satisfy the equation; therefore $\underline{x=7}$.

3. UNITY.—Solve:—
$$2x-\{(2x+1)-(3x-6)\}=35-3[2x-\{10-(2x-1)\}].$$
(*Jones and Cheyne.*)
$$2x-\{(2x+1)-(3x-6)\}=35-3[2x-\{10-(2x-1)\}]$$
$$2x-\{2x+1-3x+6\}=35-3[2x-\{10-2x+1\}]$$
$$2x-\{7-x\}=35-3[2x-\{11-2x\}]$$
$$2x-7+x=35-3[2x-11+2x]$$
$$3x-7=35-3[4x-11]$$
$$3x-7=35-12x+33$$
$$3x+12x=68+7$$
$$15x=75$$
$$\therefore x=5.$$

Note.—Perhaps 90 per cent.

4. INQUISITIVE.—Simplify, exhibiting work in full:—
$$\frac{x}{(x-y)(x-z)}+\frac{y}{(y-z)(y-x)}+\frac{z}{(z-x)(z-y)}.$$
(*Edinburgh University Senior Certificate*, 1884-5.)
$$\frac{x}{(x-y)(x-z)}+\frac{y}{(y-z)(y-x)}+\frac{z}{(z-x)(z-y)}$$
$$=\frac{x}{(x-y)(x-z)}+\frac{y}{(y-z)\times-(x-y)}+\frac{z}{-(z-x)\times-(y-z)}$$
$$=\frac{x}{(x-y)(x-z)}-\frac{y}{(x-y)(y-z)}+\frac{z}{(x-z)(y-z)}$$
$$=\frac{x(y-z)-y(x-z)+z(x-y)}{(x-y)(x-z)(y-z)}$$
$$=\frac{xy-xz-xy+yz+xz-yz}{(x-y)(x-z)(y-z)}$$
$$=\underline{0}. \text{ Ans.}$$

5. CORRESPONDENT.—Solve:—
$$2\left(\frac{1}{x^n}+x^{-\frac{1}{n}}\right)=5. \quad (\textit{Todhunter.})$$
$$2\left(\frac{1}{x^n}+x^{-\frac{1}{n}}\right)=5$$
$$\frac{1}{x^n}+x^{-\frac{1}{n}}=\tfrac{5}{2}$$
$$x^{\frac{1}{n}}+\frac{1}{x^{\frac{1}{n}}}=\tfrac{5}{2}$$
$$\frac{2}{x^{\frac{1}{n}}}+1=\tfrac{5}{2}\frac{1}{x^{\frac{1}{n}}}$$
$$\frac{2}{x^{\frac{1}{n}}}-\tfrac{5}{2}\frac{1}{x^{\frac{1}{n}}}=-1$$
$$\frac{2}{x^{\frac{1}{n}}}-\tfrac{5}{2}\frac{1}{x^{\frac{1}{n}}}+(\tfrac{5}{4})^2=-1+\tfrac{2}{4}^5$$
$$=\tfrac{9}{1}\tfrac{}{6}$$
$$\frac{1}{x^{\frac{1}{n}}}-\tfrac{5}{4}=\pm\tfrac{3}{4}$$
$$\frac{1}{x^{\frac{1}{n}}}=\pm\tfrac{3}{4}+\tfrac{5}{4}$$
$$=2, \text{ or } \tfrac{1}{2}$$
$$\therefore \underline{x=2^n, \text{ or } 2^{-\frac{1}{n}}}.$$

6. C. H. DUNN.—A man borrows from another the sum of £400 at 4 per cent. per annum. The whole is to be paid off by annual payments of principal and interest in 30 years. State the sum required to be paid each year.

Let A denote an annual payment in pounds, n the number of years, R the amount of one pound in one year, and P the amount of the loan in pounds.

$$\text{Then, } PR^n = \frac{R^n - 1}{R - 1}A,$$

$$\therefore 400 \times (\tfrac{26}{25})^{30} = \frac{(\frac{26}{25})^{30} - 1}{\frac{26}{25} - 1}A,$$

$$\left\{\begin{aligned}\text{Log. } (\tfrac{26}{25})^{30} &= (\log. 26 - \log. 25) \times 30\\ &= (1{\cdot}4149733 - 1{\cdot}3979400) \times 30\\ &= {\cdot}0170333 \times 30\\ &= {\cdot}5109990\\ &= \log. 3{\cdot}243389\end{aligned}\right.$$

$$\therefore 400 \times 3{\cdot}243389 = \frac{3{\cdot}243389 - 1}{\frac{1}{25}}A,$$

$$16 \times 3{\cdot}243389 = 2{\cdot}243389A,$$

$$\therefore A = \frac{51{\cdot}894224}{2{\cdot}243389}£$$

$$= £23\ 2s.\ 8d. \quad \text{Ans.}$$

7. G. S.—If $\frac{a}{b} = \frac{c}{d} = \frac{e}{f}$,

then each fraction $= \frac{ma + nc + pe}{mb + nd + pf}$.

If $\frac{y+z}{3b-c} = \frac{z+x}{3c-a} = \frac{x+y}{3a-b}$,

then each fraction $= \frac{x+y+z}{a+b+c} = \frac{ax+by+cz}{a^2+b^2+c^2}$.

(*Certificate Exam.*, 1883.)

Let $K = \frac{a}{b} = \frac{c}{d} = \frac{e}{f}$;

Then, $Kb = a$, $Kd = c$, $Kf = e$;

$\therefore m(Kb) + n(Kd) + p(Kf) = ma + nc + pe$,

$K(mb + nd + pf) = ma + nc + pe$,

$$\therefore K = \underline{\frac{ma + nc + pe}{mb + nd + pf}}.$$

Let $K = \frac{y+z}{3b-c} = \frac{z+x}{3c-a} = \frac{x+y}{3a-b}$;

Then, $K(3b - c) + K(3c - a) + K(3a - b)$

$= y + z + z + x + x + y$,

$3Kb - Kc + 3Kc - Ka + 3Ka - Kb = 2(x + y + z)$,

$2K(a + b + c) = 2(x + y + z)$

$$\therefore K = \underline{\frac{x+y+z}{a+b+c}}.$$

$K(a + b + c) - K(3b - c) = x + y + z - (y + z)$,

$K(a + b + c - 3b + c) = x + y + z - y - z$.

$K(a - 2b + 2c) = x$,

$$\underline{K(a^2 - 2ab + 2ac) = ax};$$

$K(a + b + c) - K(3c - a) = x + y + z - (z + x)$,

$K(a + b + c - 3c + a) = x + y + z - z - x$,

$K(2a + b - 2c) = y$,

$$\underline{K(2ab + b^2 - 2bc) = by};$$

$K(a + b + c) - K(3a - b) = x + y + z - (x + y)$,

$K(a + b + c - 3a + b) = x + y + z - x - y$,

$K(-2a + 2b + c) = z$,

$$\underline{K(-2ac + 2bc + c^2) = cz};$$

$\therefore K(a^2 - 2ab + 2ac + 2ab + b^2 - 2bc - 2ac + 2bc + c^2)$

$= ax + by + cz$,

$K(a^2 + b^2 + c^2) = ax + by + cz$,

$$\therefore K = \underline{\frac{ax + by + cz}{a^2 + b^2 + c^2}}.$$

8. ESSAYIST.—If $a_1 : b_1 = a_2 : b_2$, show that

$$\frac{m_1a_1 + m_2a_2}{m_1b_1 + m_2b_2} = \frac{a_1}{b_1}.$$

Let $K = \frac{a_1}{b_1} = \frac{a_2}{b_2}$;

Then, $Kb_1 = a_1$, $Kb_2 = a_2$;

$\therefore m_1(Kb_1) + m_2(Kb_2) = m_1a_1 + m_2a_2$,

$K(m_1b_1 + m_2b_2) = m_1a_1 + m_2a_2$,

$$\therefore K = \frac{m_1a_1 + m_2a_2}{m_1b_1 + m_2b_2}.$$

$$\therefore \underline{\frac{m_1a_1 + m_2a_2}{m_1b_1 + m_2b_2} = \frac{a_1}{b_1}}.$$

9. SOLICITOR.—If $a_1 : b_1 = a_2 : b_2 = a_3 : b_3$, show that $a_1^2 + a_2^2 + a_3^2 : b_1^2 + b_2^2 + b_3^2 :: a_1^2 : b_1^2$.

(*Hamblin Smith.*)

Let $K = \frac{a_1}{b_1} = \frac{a_2}{b_2} = \frac{a_3}{b_3}$;

Then, $Kb_1 = a_1$, $Kb_2 = a_2$, $Kb_3 = a_3$;

$\therefore (Kb_1)^2 + (Kb_2)^2 + (Kb_3)^2 = a_1^2 + a_2^2 + a_3^2$,

$K^2(b_1^2 + b_2^2 + b_3^2) = a_1^2 + a_2^2 + a_3^2$,

$$\therefore K^2 = \underline{\frac{a_1^2 + a_2^2 + a_3^2}{b_1^2 + b_2^2 + b_3^2}}.$$

But, $K = \frac{a_1}{b_1}$, $\therefore K^2 = \frac{a_1^2}{b_1^2}$;

$$\therefore \frac{a_1^2 + a_2^2 + a_3^2}{b_1^2 + b_2^2 + b_3^2} = \frac{a_1^2}{b_1^2},$$

That is, $\underline{a_1^2 + a_2^2 + a_3^2 : b_1^2 + b_2^2 + b_3^2 :: a_1^2 : b_1^2}$.

10. J. W. H.—If $a : b :: c : d$, show that

$$\frac{pa^2 + qab + rb^2}{la^2 + mab + nb^2} = \frac{pc^2 + qcd + rd^2}{lc^2 + mcd + nd^2}.$$

(*Todhunter's* 'Algebra for Beginners.')

$\frac{a}{b} = \frac{c}{d}$; $\therefore \frac{pa}{b} = \frac{pc}{d}$;

$\frac{b}{a} = \frac{d}{c}$; $\therefore \frac{rb}{a} = \frac{rd}{c}$;

$\therefore \frac{pa}{b} + \frac{rb}{a} = \frac{pc}{d} + \frac{rd}{c}$,

$\frac{pa}{b} + q + \frac{rb}{a} = \frac{pc}{d} + q + \frac{rd}{c}$,

$\frac{pa^2 + qab + rb^2}{ab} = \frac{pc^2 + qcd + rd^2}{cd}$;

Similarly it can he shown that

$\frac{la^2 + mab + nb^2}{ab} = \frac{lc^2 + mcd + nd}{cd}$;

$\therefore \frac{pa^2 + qab + rb^2}{ab} \times \frac{ab}{la^2 + mab + nb^2}$

$= \frac{pc^2 + qcd + rd^2}{cd} \times \frac{cd}{lc^2 + mcd + na^2}$

Wherefore, $\underline{\frac{pa^2 + qab + rb^2}{la^2 + mab + nb^2} = \frac{pc^2 + qcd + rd^2}{lc^2 + mcd + nd^2}}$.

11. CARLOS.—Reduce the denary number of 16784 to the duodenary scale; divide 42404 by 871 in the scale of 11; and find the number in the scale of 4, which when divided by 3 gives the quotient of 133. (*Civil Service, Lower Division*, May, 1884.)

12 | 16784
12 | 1398 . . 8
12 | 116 . . . 6
9 . . . 8

$\therefore$ 16784 in the denary scale $= \underline{9868}$ in the duodenary scale.

871)42404(54. Ans.
3425
3164
3164

133×3 in scale of $4 = \underline{1131}$. Ans.

12. ARCY.—Solve:—

$\frac{x}{a} + \frac{y}{b} = 2$, $x^2 + y^2 = ax + by$.

(*Todhunter's* 'Algebra for Beginners.')

(1) $\frac{x}{a} + \frac{y}{b} = 2$

(2) $x^2 + y^2 = ax + by$

(1) $bx + ay = 2ab$

$ay = 2ab - bx$

$$\therefore y = \underline{\frac{2ab - bx}{a}}.$$

(2) $x^2+\left(\frac{2ab-bx}{a}\right)^2=ax+b\left(\frac{2ab-bx}{a}\right)$

$x^2+\frac{4a^2b^2-4ab^2x+b^2x^2}{a^2}=ax+\frac{2ab^2-b^2x}{a}$

$a^2x^2+4a^2b^2-4ab^2x+b^2x^2=a^3x+2a^2b^2-ab^2x$

$a^2x^2+b^2x^2-a^3x+ab^2x-4ab^2x=2a^2b^2-4a^2b^2$

$(a^2+b^2)x^2-a(a^2+3b^2)x=-2a^2b^2$

$x^2-\frac{a(a^2+3b^2)x}{a^2+b^2}=-\frac{2a^2b^2}{a^2+b^2}$

$x^2-\frac{a(a^2+3b^2)x}{a^2+b^2}+\left\{\frac{a(a^2+3b^2)}{2(a^2+b^2)}\right\}^2$

$=\frac{a^2(a^4+6a^2b^2+9b^4)-8a^2b^2(a^2+b^2)}{4(a^2+b^2)^2}$

$=\frac{a^6+6a^4b^2+9a^2b^4-8a^4b^2-8a^2b^4}{4(a^2+b^2)^2}$

$=\frac{a^6-2a^4b^2+a^2b^4}{4(a^2+b^2)^2}$

$=\frac{a^2(a^4-2a^2b^2+b^4)}{4(a^2+b^2)^2}$

$x-\frac{a(a^2+3b^2)}{2(a^2+b^2)}=\pm\frac{a(a^2-b^2)}{2(a^2+b^2)}$

$x=\frac{\pm(a^3-ab^2)+(a^3+3ab^2)}{2(a^2+b^2)}$

$=\frac{2a^3+2ab^2}{2(a^2+b^2)}$, or $\frac{4ab}{2(a^2+b^2)}$

$\therefore x=a$, or $\frac{2ab^2}{a^2+b^2}$.

$y=\frac{2ab-bx}{a}$

$=\frac{2ab-ab}{a}$, or $\frac{2ab-\frac{2ab^3}{a^2+b^2}}{a}$

$=b$, or $\frac{2a^3b}{a(a^2+b^2)}$

$\therefore y=b$, or $\frac{2a^2b}{a^2+b^2}$.

13. IGNORAMUS.—Solve :—

$3yz+2zx-4xy=16$, $2yz-3zx+xy=5$, $4yz-zx-3xy=15$.

(*Todhunter's* 'Algebra for Beginners.')

(1) $3yz+2xz-4xy=16$
(2) $2yz-3xz+xy=5$
(3) $4yz-xz-3xy=15$
(1) $6yz+4xz-8xy=32$
(2) $6yz-9xz+3xy=15$

$13xz-11xy=17$ (4)

(2) $4yz-6xz+2xy=10$
(3) $4yz-xz-3xy=15$

$-5xz+5xy=-5$

$xz-xy=1$ (5)

(4) $13xz-11xy=17$
(5) $13xz-13xy=13$

$2xy=4$

$\therefore xy=2$.

(5) $xz-xy=1$

$xz-2=1$

$\therefore xz=3$.

(1) $3yz+2xz-4xy=16$

$3yz+6-8=16$

$3yz=18$

$\therefore yz=6$.

$xy\times xz=2\times 3$

$x^2yz=6$

$x^2\times 6=6$

$x^2=1$

$\therefore x=\pm 1$.

$xy=2$

$\therefore y=\pm 2$.

$xz=3$

$\therefore z=\pm 3$.

14. F. HOLTON.—Simplify $\frac{a^{-1}+a^{-1}b^{-3}}{b^{-1}+b^{-1}}$ and $\frac{2a^2+ab-b^2}{a^3+a^2b-a-b}$. (*Colenso.*)

$\frac{a^{-1}+a^{-1}b^{-3}}{b^{-1}+b^{-1}}$

$=\frac{\frac{1}{a}+\frac{1}{a}\times\frac{1}{b^3}}{b-1+\frac{1}{b}}$

$=\frac{\frac{1}{a}+\frac{1}{ab^3}}{\frac{b^2-b+1}{b}}$

$=\frac{\frac{b^3+1}{ab^3}}{\frac{b^2-b+1}{b}}$

$=\frac{b^3+1}{ab^2(b^2-b+1)}$

$=\frac{(b+1)(b^2-b+1)}{ab^2(b^2-b+1)}$

$=\frac{b+1}{ab^2}$. Ans.

$\frac{2a^2+ab-b^2}{a^3+a^2b-a-b}$

$=\frac{(2a-b)(a+b)}{a^2(a+b)-(a+b)}$

$=\frac{(2a-b)(a+b)}{(a^2-1)(a+b)}$

$=\frac{2a-b}{a^2-1}$. Ans.

15. R. R. P.—In what time will a sum of money double itself at $2\frac{1}{2}$ per cent. compound interest?

(Log 1·025 = ·01072, log 2 = ·301031)

Let P denote the principal, and n the number of years :

Then, $P\left(1+\frac{2\frac{1}{2}}{100}\right)^n=2P$,

$(1+\frac{1}{40})^n=2$,

$(1\cdot025)^n=2$,

$n\log 1\cdot025=\log 2$,

$\therefore n=\frac{\log 2}{\log 1\cdot025}$

$=\frac{\cdot30103}{\cdot01072}$

$=28\frac{87}{107}$.

$\therefore$ Time = a little over 28 years.

16. C. E. K.—Prove that in taking the square root of a number when $n+1$ digits in the root have been obtained by the ordinary rule, n more may be obtained by simple division.

Ex. Find $\sqrt{2}$ to 5 places of decimals.

(The proof of the above appeared in our last issue.)

2(1·414
1
24 | 100
96
281 | 400
281
2824 | 11900
11296
2828)60400(21
5656
3840
2828
1012

$\therefore \sqrt{2}=1\cdot41421\ldots$. Ans.

17. F. W. G.—Solve:—

$$x^{-2n} - x^{-n} = 20. \quad (\textit{Hamblin Smith.})$$

$$x^{-2n} - x^{-n} = 20$$

$$x^{-2n} - x^{-n} + (\tfrac{1}{2})^2 = 20 + \tfrac{1}{4}$$

$$= \tfrac{81}{4}$$

$$x^{-n} - \tfrac{1}{2} = \pm\tfrac{9}{2}$$

$$x^{-n} = \pm\tfrac{9}{2} + \tfrac{1}{2}$$

$$= 5, \text{ or } -4$$

$$\frac{1}{x^n} = 5, \text{ or } -4$$

$$x^n = \tfrac{1}{5}, \text{ or } -\tfrac{1}{4}$$

$$\therefore \underline{x = (\tfrac{1}{5})^{\frac{1}{n}}, \text{ or } (-\tfrac{1}{4})^{\frac{1}{n}}.}$$

Arithmetic.

1. Ver Luisant and Topical Bob.—Ash saplings after 5 years' growth are worth 1s. 3d., and increase in value 1s. 3d. each year afterwards. For their growth they require each twice as many square yards as the number of years they are intended to grow before cutting. A plantation is arranged so that each year the same number may be ready for cutting. Find the greatest annual income which can be obtained per acre, allowing 20 per cent. for expenses. (*Brook Smith.*)

At the end of 5 years gross annual income per acre

$$= (\tfrac{1}{5} \times \frac{4840}{5\times 2} \times \tfrac{4}{5})\text{s.}$$

$$= 121\text{s.};$$

At the end of 6 years, etc. $= (\tfrac{1}{6} \times \frac{4840}{6\times 2} \times \tfrac{5}{6})\text{s.}$

$$= 168\tfrac{3}{11}\text{s.};$$

" " 7 " $= (\tfrac{1}{7} \times \frac{4840}{7\times 2} \times \tfrac{6}{7})\text{s.}$

$$= 185\tfrac{5}{11}\text{s.};$$

" " 8 " $= (\tfrac{1}{8} \times \frac{4840}{8\times 2} \times \tfrac{7}{8})\text{s.}$

$$= 189\tfrac{3}{11}\text{s.};$$

" " 9 " $= (\tfrac{1}{9} \times \frac{4840}{9\times 2} \times \tfrac{8}{9})\text{s.}$

$$= 186\tfrac{2}{3}\text{s.};$$

" " 10 " $= (\tfrac{1}{10} \times \frac{4840}{10\times 2} \times \tfrac{9}{10})\text{s.}$

$$= 181\tfrac{1}{2}\text{s.};$$

" " 11 " $= (\tfrac{1}{11} \times \frac{4840}{11\times 2} = \tfrac{10}{11})\text{s.}$

$$= 175\text{s.};$$

It is thus evident that the income increases up to the 8th year, and then it decreases;

∴ Annual income per acre at the end of 8 years

$$= \tfrac{4}{5} \text{ of } 189\tfrac{3}{11}\text{s.}$$

$$= \frac{\overset{605}{\cancel{2420}} \times \overset{4}{\cancel{8}}}{\cancel{5} \times \cancel{11}}\text{s.}$$

$$= 151\tfrac{1}{11}\text{s.}$$

$$= \underline{£7\ 11\text{s.}\ 3\text{d.}} \quad \text{Ans.}$$

2. Sand Hall.—Which is the most valuable, so far as principal is concerned, £850 stock in the 3 per cents. at 93, or £817 13s. to be paid in a year's time, interest being reckoned at 3½ per cent.? What income would be derived from each? (*Hamblin Smith.*)

$$\underset{2}{\cancel{£100}} : \underset{17}{\cancel{£850}} :: 93 : \text{Value of stock.}$$

$$\begin{array}{r} 17 \\ \hline 2)1581 \\ \hline £790\tfrac{1}{2} \end{array}$$

$$£103\tfrac{1}{2} : £817\ 13\text{s.} :: £10 : \text{Present value of debt.}$$

$$\begin{array}{r} 20 \\ \hline 207 \\ \hline \end{array} \qquad \begin{array}{r} 20 \\ \hline 16353 \\ 79 \\ \hline \end{array}$$

$$= \underline{£790.}$$

∴ Stock is the most valuable.

Income from stock $= (3 \times 8\tfrac{1}{3})£$

$$= \underline{£25\ 10\text{s.}};$$

" " debt $= £817\ 13\text{s.} - £790$

$$= \underline{£27\ 13\text{s.}}$$

3. Penrith.—A woman sold 7½ dozen eggs for 6s. 2d. Some she sold at 3 for 2½d., others at 8 for 6½d. How many did she sell of each sort?

$$\text{Average selling price} = \frac{6\text{s. } 2\text{d.}}{90} = \tfrac{41}{15}\text{d.};$$

$$\text{Selling price of each in 1st lot} = \frac{2\tfrac{1}{2}\text{d.}}{3} = \tfrac{5}{6}\text{d.},$$

" " " 2nd " $= \frac{6\tfrac{1}{2}\text{d.}}{8} = \tfrac{13}{16}\text{d.};$

Difference between average price and price of those in 1st lot

$$= \tfrac{5}{6}\text{d.} - \tfrac{41}{15}\text{d.} = \frac{75-74}{90}\text{d.} = \tfrac{1}{90}\text{d.};$$

Difference between average price and price of those in 2nd lot

$$= \tfrac{41}{15}\text{d.} - \tfrac{13}{16}\text{d.} = \frac{592-585}{720}\text{d.} = \tfrac{7}{720}\text{d.};$$

∴ No. in 1st lot : No. in 2nd lot :: $\tfrac{7}{720}$d. : $\tfrac{1}{90}$d.,

:: 7 : 8;

7+8=15; 7½ dozen ÷ 15 = ½ dozen;

∴ No. in 1st lot = ½ dozen × 7 = 3½ dozen
" 2nd " = " × 8 = 4 " } Ans.

4. Ex P. T.—A quantity of wine is sold to A, at a certain loss per cent. Then A sells it to B, losing at the same rate; but B sells it to C for the original cost price, and gains thereby 44 per cent. on his outlay. What was the loss per cent. at which A and B sold the wine?

$$\text{Selling price to A} = \text{Cost price} \times \frac{100 - \text{Loss }\%}{100};$$

$$\text{Selling price to B} = \text{Cost price} \times \frac{100 - \text{Loss }\%}{100} \times \frac{100 - \text{Loss }\%}{100};$$

" " " C = Cost price $\times \frac{100 - \text{Loss }\%}{100}$

$$\times \frac{100 - \text{Loss }\%}{100} \times \tfrac{144}{100};$$

$$\therefore \text{Cost price} \times \frac{100 - \text{Loss }\%}{100} \times \frac{100 - \text{Loss }\%}{100} \times \tfrac{144}{100} = \text{Cost price},$$

$$\frac{100 - \text{Loss }\%}{100} \times \frac{100 - \text{Loss }\%}{100} \times \tfrac{144}{100} = 1,$$

$$(100 - \text{Loss }\%) \times (100 - \text{Loss }\%) = 10{,}000 \times \tfrac{100}{144},$$

$$(100 - \text{Loss }\%)^2 = \tfrac{1000000}{144},$$

$$100 - \text{Loss }\% = \sqrt{\tfrac{1000000}{144}}$$

$$= \tfrac{1000}{12}$$

$$= 83\tfrac{1}{3},$$

$$100 - 83\tfrac{1}{3} = \text{Loss }\%.$$

$$\therefore \underline{\text{Loss }\% = 16\tfrac{2}{3}}. \quad \text{Ans.}$$

Note.—Your small hand will perhaps obtain full marks, and the other writing 85 per cent.

5. Perplexed.—If a woman by selling eggs at 16d. per doz. gain 8 per cent., how many must she sell for 10s. to gain 20 per cent.?

Selling price per egg in second case

$$= \tfrac{4}{3}\text{d.} \times \frac{100+20}{100+8}$$

$$= \left(\tfrac{4}{3} \times \frac{\overset{10}{\cancel{120}}}{\underset{9}{\cancel{108}}}\right)\text{d.}$$

$$= \tfrac{40}{27}\text{d.};$$

∴ No. of eggs $= 10\text{s.} \div \tfrac{40}{27}\text{d.}$

$$= \frac{\overset{3}{\cancel{120}} \times 27}{\underset{4}{\cancel{40}}}$$

$$= \underline{81.} \quad \text{Ans.}$$

6. X. Y. Z.—A general contracted to pay £5454 for 13,635 pairs of boots and shoes for his army. The price of each pair of shoes was to that of each pair of boots as 5 to 8, but the number of the pairs of shoes was to the number of the pair of boots as 2 to 1. Give the number and prices respectively of the pairs of the boots and shoes. (*P. T. Examination.*)

No. of pairs of boots $= 13{,}635 \times \frac{1}{1+2}$
$= \frac{1}{3}$ of $13{,}635 = 4545$;
" " shoes $= 4545 \times 2 = 9090$.
Price of the boots $= £5454 \times \frac{8 \times 1}{(5 \times 2) + (8 \times 1)}$
$= £5454 \times \frac{8}{18}$
$= £2424$;
" " shoes $= £3030$;
∴ Price of a pair of boots $= £2424 \div 4545$
$= £\frac{8}{15}$
$= 10s.\ 8d.$;
" " " shoes $= £3030 \div 9090$
$= £\frac{1}{3}$
$= 6s.\ 8d.$

7. DUBIUM.—If money invested in the 3 per cents. give exactly £3 per cent. after paying 1s. in the £ as income-tax, find the price, allowing $\frac{1}{8}$ per cent. as brokerage. (*Cambridge Local Senior*, 1883.)

s. £ £
19 : 3 :: 1 : Percentage with income-tax.
$= \frac{3}{19}£$
$= £3\frac{3}{19}$.

£ £ £
∴ $3\frac{3}{19}$: 3 :: 100 : Price of stock with brokerage.
$= \frac{\cancel{3} \times \cancel{100} \times 19}{\cancel{19}\ \cancel{3}}£$
$= £95$.

∴ Price of stock without brokerage $= 95 - \frac{1}{8} = 94\frac{7}{8}$. Ans.

8. QUIZ.—A bicyclist ran $4\frac{1}{2}$ miles in 17 minutes. The distance made in the last minute was $\frac{3}{4}$ of that made in the first minute, and the distance made in each successive minute was less than that made in the preceding minute by the same quantity. Find the average and decrease per minute. (*Certificate Exam.*, 1883.)

Average rate per minute $= 4\frac{1}{2}$ miles $\div 17 = \frac{1}{2}$ mile.
Decrease per minute $= \frac{1 - \frac{3}{4}}{16}$ of rate of first minute
$= \frac{1}{64}$ of rate of first minute;
Rate of first minute $= 4\frac{1}{2}$ miles $\div \frac{\text{Sum of Nos. from 40 to 24}}{40}$
$= 4\frac{1}{2}$ miles $\div \frac{\cancel{544}}{40}$
$= \left(\frac{17}{4} \times \frac{5}{\cancel{68}}\right)$ mile
$= \frac{85}{4 \cdot 68}$ mile;
∴ Decrease per minute $= \frac{1}{\cancel{64}\ 8}$ of $\frac{\cancel{5}}{16}$ mile
$= \frac{1}{128}$ mile.

9. M. R. S.—A gardener was handed a number of shrubs to plant in rows; he tried 10 in each row, then 12 in each, and afterwards 15 in each row, but had always 9 left. On trying 13 in each he had none left. What is the smallest number of shrubs which could have been given him? (*Civil Service Arithmetic.*)

L.C.M. of 10, 12, and 15 = 60;
∴ No. will be a multiple of 60 + 9;
The smallest multiple of 60 divided by 13 leaving a remainder of 4 is 420;
∴ Smallest No. of shrubs = 420 + 9
$= 429$. Ans.

Note.—Some letters in your writing are formed imperfectly, especially *c*, *s*, and the looped letters. Perhaps 80 per cent.

10. PUZZLED.—What sum invested in the 3 per cents. at 90 will amount to £23,112 in $23\frac{1}{2}$ years, simple interest? If the funds rose to 96, how much sooner would this sum be realised?

$£90 + (£3 \times 23\frac{1}{2}) = £90 + £70\frac{1}{2} = £160\frac{1}{2}$;

£ £ £
∴ $160\frac{1}{2}$: 23,112 :: 90 : Sum invested.
2 2
$\cancel{321}$ $\cancel{46224}$
144
$= £12{,}960$.

In second case the amount would be realised
$\left(\frac{96 - 90}{3}\text{ or }\right)$ 2 years sooner.

11. HELPLESS.—The sum of the squares of two numbers is a square number, and the difference of their squares is a cube number. Find the two numbers. (*Cassell's Saturday Journal.*)

As the difference of the squares of the two numbers is a cube number, the two numbers have a common factor, the sum of the numbers is equal to the common factor, and the difference of the numbers is unity.
The two numbers whose difference is unity and the sum of whose squares is a square number are 3 and 4.
∴ The two numbers are $4 \times (3+4)$ and $3 \times (3+4)$
$= 4 \times 7$ and 3×7
$= 28$ and 21. Ans.

12. SARCOPHAGUS.—An agent has to receive a rent paid in corn from a tenant, and deliver it to the landlord. At each payment he uses, so as to benefit himself, a false balance, such that 9 lbs. in one scale balances 10 lbs. in the other. Corn being worth 49s. a quarter, the value of his plunder is £46 11s. What is the corn-rent? (*Hamblin Smith.*)

For a nominal qr. he receives from the tenant $\frac{10}{9}$ qr.;
" " " pays to the landlord $\frac{9}{10}$ qr.;
∴ Quantity plundered $= (\frac{10}{9} - \frac{9}{10})$ of whole
$= \left(\frac{100 - 81}{90}\right)$ "
$= \frac{19}{90}$ " ;
Quantity of plunder in qrs. $= £46\ 11s. \div 49s.$
$= 931s. \div 49s.$
$= 19$;
∴ Corn Rent $= (19 \times \frac{10}{9})$ qrs.
$= 90$ qrs. Ans.

13. E. H. C.—Four apples are worth as much as 5 plums, 3 pears as much as 7 apples, 8 apricots as much as 15 pears, and 5 apples sell for 2d. I wish to buy an equal number of each of the four fruits, and to spend an exact number of pence; find the least sum I can spend. (*Hamblin Smith.*)

5 plums are worth 4 apples,
∴ 1 plum is " $\frac{4}{5}$ apple;
3 pears are " 7 apples,
∴ 1 pear is " $\frac{7}{3}$ apple;
8 apricots are " 15 pears,
" " " 35 apples,
∴ 1 apricot is " $\frac{35}{8}$ apples;
∴ Cost of one of each of the four fruits
= Cost of $(1 + \frac{4}{5} + \frac{7}{3} + \frac{35}{8})$ apples
= " $\frac{120 + 96 + 280 + 525}{120}$ apples
$= \left(\frac{1021}{\cancel{120}} \times \frac{\cancel{2}}{5}\right)$ d.
60
$= \frac{1021}{300}$ d.;
∴ Least sum = 1021d.
$= £4\ 5s.\ 1d.$ Ans.

Note.—Thanks for solution of the other query. We understood from the correspondent that the answer was 190 qrs.

14. T. P.—From a cask of wine one-fourth is drawn off, and the cask is filled up with water; one-fourth of the mixture is then drawn off, and the cask again filled up with water; after this process has been repeated four times altogether, what fraction of the original quantity of wine will be left in the cask? How many gallons of wine will be left, if the full cask contains 128 gallons?

Quantity of wine left $= (\frac{3}{4}$ of $\frac{3}{4}$ of $\frac{3}{4}$ of $\frac{3}{4})$ of original quantity
$= \frac{81}{256}$ of original quantity. Ans.
Quantity left $= \frac{81}{256}$ of 128 gals.
$= 40\frac{1}{2}$ gals. Ans.

15. MERSEY.—A and B each invest a certain sum of money in a business. The sum which A invests is $\frac{3}{5}$ of that which B invests. At the end of 7 months A withdraws $\frac{1}{4}$ of his capital, and at the end of 9 months B withdraws $\frac{1}{3}$ of his. The profits at the end of the year are £132 12s.; how ought they to be divided?

A's share : B's share $:: (\frac{3}{4}\times 7)+(\frac{3}{4}$ of $\frac{3}{5}\times 5) : (1\times 9)+(\frac{2}{3}\times 3)$,

$:: \frac{21}{4}+\frac{3}{4} : 9+2$,

$:: \frac{28+15}{6} : \frac{36+9}{4}$,

$:: \frac{43}{6} : \frac{45}{4}$,

$:: 86 : 135$;

£ s.

$\therefore 86+135 : 86 :: 132\ 12$: A's share.

$221 : 86 :: 26532$s. : ,, ,

12

$= 1032$s.

$= £51\ 12$s.

$\therefore$ A's share $= £51\ 12$s.,

B's ,, $= £132\ 12$s. $- £51\ 12$s.

$= £81$.

16. ALFRED THE GREAT.—What must be the market value of 3 per cent. stock, in order that after deducting income-tax of 5d. in the £, it may yield 3½ per cent. interest? (*Outdoor Customs' Exam. Papers.*)

s. d. £ £ £

19 7 : 3½ :: 1 :: Percentage with income-tax.

$= £3\frac{1}{2}\times\frac{239}{240}$

24

$= \left(\frac{7}{2}\times\frac{479}{480}\right)£$

47

$= \frac{1673}{480}£$;

£ £ £

$\therefore \frac{1673}{480} : 3 :: 100$: Price of stock.

25

$= \frac{300\times 47}{1673}£$

14

$= 11\frac{1}{14}£$

$= £83\frac{1}{14}$.

$\therefore$ Price of stock $= 83\frac{1}{14}$. Ans.

17. LUDOVICUS.—A person invests £5,460 in the 3 per cents. at 91; he sells out £2,000 stock when they have risen to 93½, and the remainder when they have fallen 85; he then invests the produce in 4½ per cents. at 102. What is the difference in his income? (*Paul's 'Modern Problems.'*)

£ £ £

91 : 5460 :: 100 : Amount of stock.

60

$= £6{,}000$.

Income in first case = 3 per cent. on £6,000 = £180.

Amount realised by sale $= (£93\frac{1}{2}\times 20)+(£85\times 40)$

$= £1{,}870+£3{,}400$

$= £5{,}270$;

£ £ £

$\therefore 182 : 5270 :: 4\frac{1}{2}$: Income in second case.

2 155 2

9

3

$= \frac{473}{3}£$

$= £232\frac{1}{3}$.

$\therefore$ Difference in income $= (£232\frac{1}{3}-£180)$ increase

$= £52\ 10$s. increase. Ans.

18. SUDBURY.—On July 26th the sun rises at 4 hrs. 15 min. a.m., and sets at 7 hrs. 54 min. p.m.; what o'clock is it when the sun is due south? (*Hamblin Smith.*)

It will be due south at $\frac{(12\text{ hrs.}-4\text{ hrs. }15\text{ min.})+7\text{ hrs. }54\text{ min.}}{2}$ from sunrise

$= \frac{7\text{ hrs. }45\text{ min.}+7\text{ hrs. }54\text{ min.}}{2}$ from sunrise

$= \frac{15\text{ hrs. }39\text{ min.}}{2}$ from sunrise

$= 7\text{ hrs. }49\frac{1}{2}\text{ min.}$ from sunrise

$= 4\text{ hrs. }15\text{ min. a.m.}+7\text{ hrs. }49\frac{1}{2}\text{ min.}$

$= 4\frac{1}{2}$ min. past 12. Ans.

19. RHODANUS.—How many parcels of 6 lbs. and 8 lbs. each can a grocer make out of a hogshead of sugar, weighing 4 cwt. 3 qrs. 14 lbs., so as to have the same number of parcels of each sort? (*Barnard Smith.*)

No. of parcels of each sort = 4 cwt. 3 qrs. 14 lbs. ÷ (6 lbs. + 8 lbs.)

$= 19\frac{1}{2}$ qrs. ÷ 14 lbs.

$= 39$ half-qrs. ÷ ½ qr.

$= 39$. Ans.

20. VIOLET.—A clock and a watch together cost 35 guineas. The clock cost 19⅛ guineas more than the watch. Find what percentage of the whole cost the watch was worth.

Cost of watch $= (35-19\frac{1}{8})$ guineas ÷ 2

$= 15\frac{7}{8}$ guineas ÷ 2

$= 7\frac{15}{16}$ guineas;

guineas £ guineas

$\therefore \frac{255}{7} : \frac{1785}{20} :: 7\frac{15}{16}$: Percentage.

$\therefore$ Percentage $= 7\frac{15}{16}\times\frac{20}{357}$

5

$= \frac{125}{16}\times\frac{20}{7}$

4

$= \frac{500}{112}$

$= 22\frac{11}{28}$. Ans.

21. J. E., B.-O.-T.—The weight of a gold 10-franc piece is 49·78 grs.; the weight of a silver 5-franc piece is 385·8 grs., of which the equivalent in pure silver is ·782 oz. Troy. If the relative value of coined gold and silver be 19·29 : 1, find the intrinsic value of a gold 10-franc piece, the intrinsic value of pure silver being 4s. 2d. per oz. Troy. (*Lower Division*, May, 1884.)

Intrinsic value of 10-franc piece

24·89

$= 4$s. 2d. $\times$ ·782 $\times \frac{49\cdot78\times 19\cdot29}{385\cdot8}$

7

10

$= 4$s. 2d. $\times$ ·782 $\times$ 2·489

$= (1\cdot946398\times 50)$d.

$= 97\cdot3199$d.

$= 8$s. 1·3199d. Ans.

22. JOHN.—If 23 oxen consume 8 acres of pasture in 26 days, and 25 oxen consume 7 acres of the same in 20 days, the grass growing uniformly, how many acres of it would 33 oxen consume in 5½ days?

oxen oxen

(23 − No. supplied by growing grass) : (25 − No. supplied by growing grass)

days days

26 : 20

acres acres

:: 8 : 7,

$\therefore$ (23 − No. supplied by growing grass) oxen $\times$ 26 $\times$ 7

$=$ (25 − No. supplied by growing grass) oxen $\times$ 20 $\times$ 8,

(23 − No. supplied) oxen $\times$ 91

$=$ (25 − No. supplied) oxen $\times$ 80,

2093 oxen − 91 times No. of oxen supplied

$=$ 2000 oxen − 80 times No. of oxen supplied,

(2093 − 2000) oxen $=$ (91 − 80) times No. of oxen supplied,

11 times No. of oxen supplied $=$ 93 oxen,

$\therefore$ No. of oxen supplied by growing grass $= \frac{93}{11}$.

oxen oxen

$\therefore (23-\frac{93}{11})$: $(33-\frac{93}{11})$ } acres

days : days } :: 8 : Part consumed.

26 5½

$\frac{160}{11}$: $\frac{270}{11}$ } acres

26 : $\frac{11}{2}$ } :: 8 : Part consumed.

$= \frac{30\ 2}{270\times 11\times 2}$ acres.

$= 3$ acres. Ans.

23. SPES.—An up-train 88 yds. long, travelling at the rate of 35 miles an hour, meets a down-train 88 yds. long at 12 o'clock, and passes it in six seconds. At 15 minutes and 3 seconds past 12 the up-train meets a second down-train 132 yds. long, and passes it also in 6 seconds. At what time will the second down-train run into the first? (*Barnard Smith's* 'Examination Questions in Arithmetic.')

Distance between the two down-trains at 12 o'clock
$= \{(88+132) \text{ yds.} \times \frac{15 \text{ mins. } 3 \text{ sec.}}{6 \text{ sec.}}\} - 88 \text{ yds.}$
$= (220 \text{ yds.} \times 2\tfrac{1}{2}\tfrac{2}{3}) - 88 \text{ yds.}$
$= 33{,}110 \text{ yds.} - 88 \text{ yds.}$
$= 33{,}022 \text{ yds.}$;
Gain by second down-train in 6 sec. $= (132-88)$ yds. $= 44$ yds.;
$\therefore$ The collision will occur at $\frac{33022 \times 3}{44}$ sec. past 12
$= 4{,}503$ sec. past 12
$= 1$ hr. 15 min. 3 sec. past 12
$=$ 15 min. 3 sec. past 1.

Mensuration.

1. DERWENT.—The cost of carpeting a room 12 feet high at 6s. 8d. per square yard is £15, and the cost of painting two-thirds of the area of the walls at 10d. per square foot is £28; find the length and breadth of the room. (*Certificate Exam.*, 1883.)

Area of floor $= \frac{£15}{6s.\ 8d.}$ sq. yds.
$= 45$ sq. yds.;
,, walls $= \left(\frac{£28}{10d.} \times \frac{4}{3}\right)$ sq. ft.
$= \frac{28 \times 14 \times 3}{2 \times 9}$ sq. yds.
$= 112$ sq. yds.;
Area of walls = Perimeter of room × Height;
$\therefore$ Perimeter of room in yds. × 4 yds. $= 112$ sq. yds.,
Perimeter of room $= 28$ yds.;
$\therefore$ Length + Breadth $= 14$ yds.,
Breadth $= 14$ yds. − Length;
Length × Breadth $= 45$ sq. yds.,
Length (14 yds. − Length) $= 45$ sq. yds.,
14 times Length in yds. − (Length in yds.)$^2 = 45$,
(Length in yds.)^2 − 14 times Length in yds. $= -45$,
(Length in yds.)^2 − 14 times Length in yds. $+ (7)^2 = -45 + 49$
$= 4$
Length in yds. $- 7 = \pm 2$
$\therefore$ Length in yds. $= \pm 2 + 7$
$= 9$, or 5.
$\therefore$ Length of room $= 9$ yds.,
Breadth ,, $= 5$ yds.

2. KINDNESS.—The edges of a rectangular chest, which contains 64 cubic ft., are in the proportion of 1, 2, 4; find the actual length of its edges. (*Barnard Smith.*)

Depth × Breadth × Length = Cubical content;
$\therefore$ Depth × Twice Depth × 4 times Depth $= 64$ cub. ft,
8 times Depth$^3 = 64$ cub. ft.,
Depth$^3 = 8$ cub. ft.
$\therefore$ Depth $= 2$ ft.;
Breadth $= 4$ ft.,
Length $= 8$ ft.

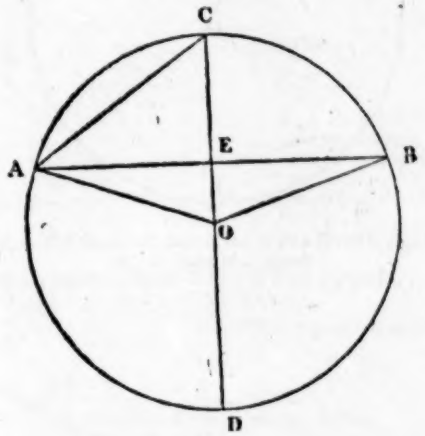
3. CECILIA.—A room is 20 ft. long and 16 ft. wide; how high must it be so that the area of the floor and ceiling together may be equal to that of the 4 walls?

Perimeter of the room × Height = Area of floor + Area of ceiling;
$\therefore$ $(20+16)$ ft. $\times 2 \times$ Height $= (20 \text{ ft.} \times 16 \text{ ft.}) \times 2$
72 ft. × Height $= 640$ sq. ft.
$\therefore$ Height $= \frac{640 \text{ sq. ft.}}{72 \text{ ft.}}$
$= \frac{80}{9}$ ft.
$= 8\frac{8}{9}$ ft. Ans.

4. G. J. HOWELL.—The sides of a rectangular field of 15 acres are as 1 : 3. What are the breadth and length?

Breadth × length = area;
$\therefore$ Breadth × 3 times breadth $= 15$ acres,
3 times breadth$^2 = (15 \times 4840)$ sq. yds.
Breadth$^2 = 24{,}200$ sq. yds.,
$\therefore$ Breadth $= \sqrt{24{,}200}$ sq. yds.
$= \sqrt{12{,}100 \times 2}$ yds.
$= 110\sqrt{2}$ yds.;
Length $= 330\sqrt{2}$ yds.

5. T. D.—What is the area of the segment of a circle, the chord of the whole arc being 60 feet, and the chord of half the arc 37·5 feet? (*Nesbit.*)

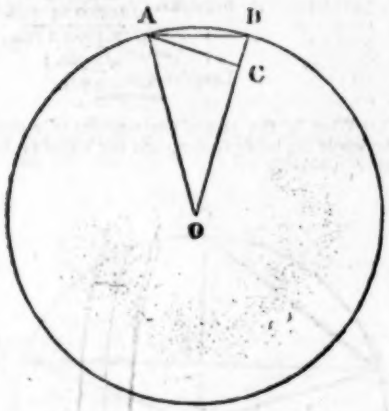


$CE^2 = AC^2 - AE^2$
$= 37{\cdot}5^2 - 30^2$
$= 1406{\cdot}25 - 900$
$= 506{\cdot}25$;
$\therefore$ CE $= \sqrt{506{\cdot}25}$
$= 22{\cdot}5$
CE × ED = AE × EB (III. 35.);
$\therefore$ $22{\cdot}5 \times$ ED $= 30^2$
$= 900$
$\therefore$ ED $= 900 \div 22{\cdot}5$
$= 40$;
CD = CE + ED
$= 22{\cdot}5 + 40$
$= 62{\cdot}5$;
$\therefore$ Radius $= 31{\cdot}25$.

Length of arc AB $= \frac{8AC - AB}{3}$
$= \frac{(37{\cdot}5 \times 8) - 60}{3}$
$= \frac{300 - 60}{3}$
$= 2\frac{4}{3}^0$
$= 80$;
Area of sector $= \frac{\text{Length of arc} \times \text{Radius}}{2}$
$= \frac{80 \times 31{\cdot}25}{2}$
$= 1{,}250$;
Area of triangle AOB = AE × EO
$= 30 \times (CO - CE)$
$= 30 \times (31{\cdot}25 - 22{\cdot}5)$
$= 30 \times 8{\cdot}75$
$= 262{\cdot}5$;
$\therefore$ Area of segment $= (1{,}250 - 262{\cdot}5)$ sq. ft.
$= 987\frac{1}{2}$ sq. ft. Ans.

6. YELLSERP.—The radius of a circle is 10 feet; the angle of the sector is 30°; find the area of the segment. (*Todhunter.*)

$$\text{Area of sector} = \frac{30^\circ}{360^\circ} \times 10^2 \times 3{\cdot}1416$$
$$= \tfrac{1}{12} \text{ of } 314{\cdot}16$$
$$= 26{\cdot}18.$$



Angle ACO is a right angle, and the angle AOC = 30°,
∴ Angle OAC = 60° (I. 32.)
∴ Triangle AOC is half an equilateral triangle, and
AC = ½ AO = 5;

$$\text{Area of triangle AOC} = \frac{\text{OB} \times \text{AC}}{2}$$
$$= \frac{10 \times 5}{2}$$
$$= 25;$$

∴ Area of segment = (26·18 − 25) sq. ft.
= 1·18 sq. ft. Ans.

General.

1. Bos.—Your query was solved in our issue for July, 1883.

2. J. W.—You will find the solution of your query in our issue for May, 1882.

3. Will-o'-th'-Wisp.—The solution of your query appeared in our last issue.

4. Bos.—You will find the solution of your query in our issue for May, 1882.

5. Normal.—The writing is judged by competent authorities. We know of no book to help you in the matter.

6. S. Allsopp.—If you will kindly comply with Rule 2 of the Query Column, we shall have pleasure in replying to your query.

7. W. A. Wood.—You will find the working correct by substituting $1ca^2$ for $18a^2$, and adding 36×4 to 99. It is simply a clerical error.

8. Patria.—Write to Rev. Canon Cromwell, St. Mark's College, Chelsea, S.W., and ask for the desired information. Thanks for correction.

9. W. Ashby.—(1) and (2) Yes. (4) All depends upon the interpretation of the wording.

10. Veritas.—248-9. Cousin, I bid you farewell: since I am not allowed to remain near you, do not forget to inform me by letter where you are.

254-6. My grief is so great, that when I ought to have most to say, I can hardly speak a word to you.

265-6. Think of the time you are compelled to spend in banishment only as something which will render more bright and pleasant your return to England.

11. Fidus Achates.—The solution of your query appeared in our issue for June, 1882.

12. Ridley.—(1) Yes. (2) Note the question. It asks for the origin. All authorities agree in saying 'ess' is derived from Latin 'ix' through the French.

Sentence.	Kind of Sentence.	Conn.	Subject.	Predicate.	Object.	Exten.
(*a*) How reverend is the face of this tall pile—looking tranquillity.	Principal Sentence.		The face of this tall pile—looking tranquillity.	is how reverend		
(*b*) Whose ancient pillars rear their marble heads to bear aloft its arched and ponderous roof by its own weight made steadfast and unmovable.	Adj. Sent. to *a*.	*In rel.*	Whose ancient pillars	rear	their lofty heads	to bear aloft its arched and ponderous roof, made steadfast and unmovable by its own weight (*purpose*).

How—adv. of degree, qual. *reverend*. Derived from A.S. *hwæt*.

whose—pers. pro., poss. case, gov. by *pillars*; from A.S. *hwa*.

ancient—adj. of quality, qual. *pillars*; from F. *ancien*, L. *ante*.

their—pers. pro., poss. case, gov. by *heads*; is almost the same form as in O.E. *thâra*. It was the poss. of the A.S. demonstrative pronoun.

heads—com. noun, plur., obj., gov. by *rear*; from A.S. *heafod*.

to bear—verb, reg., trans., act., inf., gov. by *rear*; from A.S. *beran*.

aloft—adv. of place, qual. *to bear*; formed of A.S. prefix *a*, and *lyft*, the air.

weight—abs. noun, neut., sing., obj., gov. by *by*; A.S. *wegan*, to weigh, noun form, *wiht*.

steadfast—adj. of quality, qual. *roof*; from A.S. *stede*, and *faest*, fixed.

looking—pres. part. of *to look*, referring to *pile*, used absolutely; A.S. *locian*.

tranquillity—abs. noun, obj., gov. by *looking*. From Latin *trans* and *quiesco*.

13. St. Helena.—*Elsom's* 'Kingston Working Set of Arithmetical Cards' and the 'Adaptable' Test Cards will, no doubt, suit you. Both series can be obtained through any bookseller, or direct from J. Marshall and Co., 42, Paternoster Row.

14. Owl.—*Save*—cop. conj., joining the sentences 'All the air a solemn stillness holds' and '*It be*' understood; *that*—cop. conj., joining the sentences 'It be' and 'The moping owl,' etc.

The construction is:—All the air a solemn stillness holds, save *it be* that the moping owl, etc.

Analyse as follows:—*Princ. sent.*: All the air a solemn stillness holds. *Adv. sent. of cause* (condition): It be. *Noun sent.*: That the moping owl, etc.

In analysis some would call *save that* a single connective. It would then be:—Princ. sent. as above, and 'save that the moping owl,' etc., an adv. sent. of cause (condition).

15. Science.—If your choice lies between chemistry and electricity we should recommend you to take chemistry, as some knowledge of it is indispensable for profitable study of many other subjects.

16. Leo.—'Calm' in the line, 'His broad wings lay calm and motionless,' is an adjective. It would be wrong to call it an adverb.

17. Congleton.—85.

18. C. E. K.—90. All very good. For the last query see present number of The Practical Teacher, page 402.

19. E. D. Davies.—Cannot tell you of the dictionary you want.

20. ARIOVISTUS.—The passage is too long. *Abbot's* 'Via Latina,' or '*Dr. W. Smith's* 'Principia Latina,' Parts I. and IV., and *Bradley's* 'Exercises.' You want a good grammar and dictionary. You could try *White's* or *Smith's* 'Latin Dictionary,' and *Smith's* or *Roby's* 'Latin Grammar' (small edition).

21. EIDRAH.—*Todhunter's* 'Algebra' contains what you want for Annuities. Any good arithmetic would be sufficient. For the history use *Green's* 'History of the English People,' and *Bright's* 'Constitutional History.' For the literature read *Morley's* 'First Sketch of English Literature.'

22. HOPEFUL.—You don't say what examination you wish to prepare for: there are four examinations for certificates. To pass any of them you should know more than you can get from books. You may, however, get a good deal of help from *Fitch's* 'Lecture on Education,' *Bain's* 'Education as a Science,' *Spencer's* 'Education—Intellectual, Moral, and Physical. Writing 60.

23. ANXIOUS ONE.—'Mensuration for Beginners' (*Todhunter*). *Morley's* 'First Sketch of English Literature' would, no doubt, be what you want, but does not quite answer to your query. The writing is very bad. Get a few good copy-books to have it valued, and write for twenty minutes every day, and in three months let us see the result.

24. VÆ VICTIS.—You are bound to take the Greek at the intermediate examination. Hence you would not be wasting time to begin with German. The Dublin degree is considered to be easier than the London; if it is so, you would not think it as valuable. You had better write to the registrar and get the syllabus for each and compare them.

25. JACOBUS.—No. Add *Abbot's* 'Via Latina,' 'Latin Prose through English Idiom' by the same author. For French, consult *Fasnacht's* 'Series' (published by Macmillan and Co.), and *Brachet's* 'Historical Grammar.' For algebra, use *Todhunter's* 'Algebra' (7s. 6d.). For the grammar, geography, and history, special books cannot be recommended, as you have not specified which certificate examination you refer to. For general purposes you would do well to study the grammars of Morris, Mason, and Smith. 'The Student's Hume' and *Green's* 'History' are both excellent.

26. RASEN.—Large hand, 80; small hand, 85.

27. MACBETH.—First specimen, large hand, 65; small hand, 70. Second specimen, large hand, 60; small hand, 75. The large hand has many faults. Get a good copy-book.

28. DISPUTANT.—Usage has decided that we should say 'Jones was hanged,' not 'hung.'

29. ATTILA.—The gerund is a verbal substantive, having four cases, and governing the same case as the verb it is derived from; examples:—

Ars scribendi difficilis est
Aqua nitrosa utilis est bibendo
Puer paratus est ad scribendum
Puer fatigatus est scribendo.

There are two supines, one in -u, and one in -um. The first is used after certain adjectives signifying fitness or unfitness, good or evil, as

Nefas est dictu
Amarum est gustatu.

The second is used after verbs of motion without a preposition, as 'Venit lusum.'

30. SOLICITOR.—Read the Code, Article 57, 2. You can sit if you have had a favourable report upon your teaching.

31. ARITHMETIC.—We advise you to try *Nelson's* 'Royal Series.'

32. YULE.—You must have been employed more than two years as a provisionally certificated teacher, Code, Article 57, 1.

ANSWERS TO ARITHMETICAL QUESTIONS IN THE 'SCHOLAR' FOR NOVEMBER, 1884.

STANDARD III.

A. 1. 3534+19.
2. 16502+36.
3. 3008+56.

B. 1. 6130+57.
2. 2785+39.
3. 1059+51.

C. 1. £2267 8s. 10d.
2. £33,436 11s. 4½d.
3. £188,032 8s. 9d.

D. 1. £90,900 8s. 1¾d.
2. £101 0s. 9½d.
3. £3210 0s. 10⅜d.

E. 1. 11s. 3¾d.
2. £2 9s. 2¾d.
3. £10 4s. 2d.

F. 1. £3 7s. 10½d.
2. £101 2s. 8½d.
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STANDARD IV.

A. 1. £100,189 5s. 0¾d.
2. £24,329 13s. 4¾d.
3. £369,766 13s. 5½d.

B. 1. £617 7s. 0¾d.
2. £6 13s. 9¾d.+113.
3. £731 12s. 8¾d.+10.

C. 1. 873 tons 10 cwt. 3 qrs. 10 lbs.
2. 40,789 grs.
3. 402 mls. 1 fur. 19 po. ½ yd. (=1 ft. 6 in.)

D. 1. £9137 4s. 9d.
2. £1 5s. 1¼d.+412.
3. £235 10s.

E. 1. 1173½ times.
2. 36,951,552 inches.
3. £255 7s. 4½d.

F. 1. £89 8s. 9d.
2. £958 7s. 8d.
3. £35 3s. 9½d.

STANDARD V.

A. 1. £496 3s. 1½d.
2. £3708 15s.
3. £11,747 9s. 2¼d.

B. 1. £6 5s. 1½d.
2. £324 15s.
3. £65 14s. 4¾d.

C. 1. 7 mls.
2. 38 yds. 1 qr.
3. 15 days.

D. 1. $1\frac{19}{20}$.
2. $\frac{1}{1\frac{1}{3}}$.
3. $1\frac{1}{3}$.

E. 1. £83 14s. 7¼d.
2. £128 8s. 5¼d.
3. £4 1s. 9½d.

F. 1. 80 dozen.
2. 16,436 galls.
3. £21 10s.

STANDARD VI.

A. 1. $\frac{1}{2}$.
2. $74\frac{27}{1168}$.
3. $\frac{1\frac{1}{2}+\frac{1}{3}}{1\frac{1}{2}-\frac{1}{3}}$.

B. 1. $\frac{2\frac{1}{2}\frac{1}{2}\frac{0}{0}}{7\frac{1}{8}}$.
2. ·0042.
3. $\frac{1}{8}$.

C. 1. £1 5s. $7\frac{1}{2}\frac{1}{3}$d.
2. £4 17s. $7\frac{11}{115}$d.
3. ·018...

D. 1. 8 lbs.
2. $17\frac{1}{2}$ mls.
3. 16 hrs.

E. 1. £15 4s.
2. $1\frac{1}{3}$; $\frac{2\frac{1}{2}}{4\frac{1}{6}}$.
3. 4320 times.

STANDARD VII.

A. 1. $\frac{7\frac{1}{2}}{3\frac{1}{3}\frac{1}{3}}$.
2. 5 p.c.; $7\frac{1}{2}$ p.c.; $3\frac{1}{3}$ p.c.
3. £87 16s. $1\frac{7}{11}$d.

B. 1. £6479 3s. 4d.
2. $7\frac{1}{2}$ p.c.
3. £52,166 13s. 4d.

C. 1. £50 14s. 2½d.
2. 50.
3. 10s.; 20 p.c.

Publications Reviewed.

SOME GERMAN INSTRUCTION BOOKS.

'OF making books there is no end,' is the quotation that most readily occurs to the reviewer with half a dozen educational works on German lying before him. However, he remembers that 'in the multitude of counsellors there wanteth not wisdom,' and certainly in those books now to be considered there is not a little that is suggestive and excellent.

One of these days, foreign languages will be taught as children learn their own, and grammar will be learnt, as morals are best learnt—not by precept, but by example. Instead of the inculcation of rules, there will be the acquisition of principles, by the reading of books in the tongue to be studied. The best teachers are already adopting the plan of at once introducing their pupils to a standard work of some standard author, and commencing upon that. This is far better than beginning on a

grammar, no matter how good the exercises may be. The difference is as that between the actual observation of facts and experiments, and the looking at diagrams.

When the 'one of these days' foretold above dawns, some instructor will reduce to book form the *viva voce* method of teaching. But the time is not yet, although that the time draws near, is shown by the nature of one of the books with which we now deal.

An Elementary German Grammar and Reading Book. By Ferdinand Schmidt, Ph.D. Trübner and Co.

Dr. Schmidt has evidently in mind the principle upon which we have insisted above. But he does not carry it out completely in practice. He begins well. Thus, in distinctive type, we find in his preface:—'In the author's opinion, the method of learning a language from books must resemble the way in which we learn it in life.' But he falls away, as we think, from his former high estate later on. Nay, even in this same preface is evidence of the difficulty of carrying out consistently an excellent idea. The last paragraph of the preface contains directions as to the order in which the sections of the work are to be studied. We are to begin with sections 1, 2, 3, 4, 5. So far, good. But then we are to take not 6 but 15, and only a fragment of that; then to jump on to 17, to read next one of the stories at the end of the book, and then presumably, though no directions are given, to return to the neglected sections from 6 onwards. It is clear that Dr. Schmidt is not the 'one of these days' man mentioned above. If a certain order is to be followed by a beginner in any subject, that order should be followed by the text-book he is to use.

Here and there are little slips in English. 'An *u*' instead of 'a *u*,' helps to perpetuate the old blunder of mistaking a sign for a thing, and regarding '*u*,' because it generally represents a vowel-sound, as always requiring the precedent 'an.' Nobody would think of writing 'an youth.' But to write, as many do, 'an university,' or, as Dr. Schmidt writes, 'an *u*,' is as incorrect. 'From thence,' p. 37, is another slip.

Putting on one side the fundamental mistake, as it seems to us, of placing the grammar rules and the reading book apart from each other, this work is good. The strong, weak, and mixed declensions are retained—an interesting fact, when we consider the uncertainty among grammarians as to the best way of dealing with that Hydra, the German substantive. The description of the verb (p. 39), given even before *sein* or *haben* is conjugated, is especially to be commended. That *bête noir* of the ordinary teacher, the so-called 'inseparable verbs,' Dr. Schmidt manages well. He avoids the nomenclatural blunder implied in the name just given, and carefully speaks of the prefixes only, as separable or inseparable. Another good practical point is the printing of the stories for reading alternately in English and in German characters. The list of strong verbs, without which no well-regulated grammar is complete, comes in at the end. The only regret we have is that the declensions, conjugations, rules, and so forth, are not worked in with the readings in the book, as they would be in teaching, if the teacher were able.

The other instruction books under our consideration are in no case, even as far as intention is concerned, on the lines of the new method. Four of them are from one pen.

A German Preparatory Course. German Method, German Conversational Questions, Child's First German Course. By Edward Schinzel. Williams and Norgate.

Mr. Schinzel certainly knows the uses of advertisement. Every one of his four books skilfully advertises the other three, and one of them has, quite like Mr. Augustus Harris, of Drury Lane, a testimonial from a clergyman. The author, by his method of printing words and paradigms, half in German, half in English characters, in the earlier pages of two of his books—the Preparatory Course, and the Child's First German Course—shows that he recognises the tendency to abolish the distinctive German characters. By his speedy reversion, however, to the German type only, he does little towards the furthering of that tendency.

The Preparatory Course starts with *sein*, goes on with fragments on the noun, and then makes a sudden rush into the comparison of adjectives. We doubt the wisdom of this last step. The declension of the adjective should, we think, precede its comparison. The statement that the adjective, when used predicatively, is not inflected, should, we are sure, precede both the declension and comparison. And for this reason. In the learning of languages, as in the learning of natural science, the mind longs for what we may call 'resting-places,' *i.e.*, generalisations of simple, trouble-saving order. Thus, if a beginner is shown that certain parts of speech are indeclinable, and will give him no further trouble than that of acquiring their meaning, he has at once gained something on which his mind can rest. In like fashion much is gained by telling the student of German, at the very earliest opportunity, that feminine nouns do not alter in the singular number. This welcome fact is not brought out in the Preparatory Course until p. 46, and is not even there made as clear as it might be. And the equally welcome fact that when used as a predicate the adjective is invariable, makes its first appearance on p. 26, at least fourteen pages too late. The only other fault of moment we can find with a book that is on the whole well-arranged, and ought to be useful in the hands of a good teacher, is as to the treatment of the conjunctions on p. 92. It would have been better, we think, to have distinguished at once, and in the text, between the two kinds of conjunction, and not to have referred to the co-ordinate conjunctions in a note, as if they were a grammatical after-thought. The English is at times a little loose—page 9, line 21; page 49, line 6 from end, to wit.

The German Method is on the same lines as the Course. In its use of brackets, initials, numbers, and various signs, it quite recalls Arnold's Latin Prose Composition in the good old days.

The Conversational Questions is the most useful of the quartette. Of course, it is open to the commonplace objection that a teacher who would need to use it ought not to be a teacher. But as, unhappily, there are many who would come under this description, the book should have its day. The questions are distinctly better than the time-honoured ones, as to the 'cat of my grandmother,' or the 'cheese of the joiner.' They are on real matters of fact, and of daily life. They are, if we may use the word, human, and not of the ghoulish kind, long familiarity with which in ancient grammars has bred a contempt not unmixed with horror.

The Child's First German Course ought to be at the mouth of its mother and its nurse. But assuming that this—the only natural method of teaching a child—is impracticable, this little book may serve. Grammatical rules ought to be excluded altogether in the beginning, thinks Mr. Schinzel, and although he need hardly have carried this excellent principle to the length of committing an error in grammatical construction two sentences before he enunciates the idea, he has carefully and consistently carried it out in this little volume.

German Grammar. By Clemens Schlomka, M.A., Ph.D. Maclehose and Sons, publishers to Glasgow University.

In one volume Dr. Schlomka does what Mr. Schinzel does in four, and he does it better. This is, in all respects, the best work of the six under review. We are not sure that we ought not to say it is the best of all the German grammars (and their name is legion) that we have seen. The order of succession, although to some of the old school it may appear confusing, is, in reality, philosophical. It is the outcome of a mind not only acquainted with English and German, but with human nature. With conspicuous wisdom, the gruesome rules

for pronunciation of every possible combination of letters that dishearten beginners are omitted. Only the essential facts are given. Grimm's Law is illustrated rather than formulated. At page 13 its principle is ingeniously worked in, and on page 65 similar wisdom is shown by the interpolation between *haben* and *sein* of some hints on the subjunctive and word-order. The explanation of the use of *lassen* (p. 197) is another example of the fresh thoroughness of the work, though we are half sorry that the equally excellent explanation of the use of the German active infinitive for our passive form of the verb 'to be' is not completed by the pointing out that we have in English a remnant of this construction. We say, 'This house to let,' or 'This house to be let' indifferently. Whilst '*Dieses Haus zu vermiethen*' would be the sense-equivalent of both phrases, it is the verbal equivalent also of the former. Dr. Schlomka's method with the noun and verb is far simpler than that in general use. He rejects, as to the noun, all the multitudinous declensions, lays at the outset stress on the two key-cases, the genitive singular and nominative plural, works in at once the invariability of the feminine singular, and then deals with the singular number only, and later with the plural alone. As to this last, he states frankly that the nominative plural is better learnt from a dictionary than from a grammar, and he is consistent enough to print the nominative plural after the singular nominative right through his work, whenever there is likely to be the least difficulty. The only suggestion we can make in respect to the eighteen lessons devoted to the noun is that Lesson 28, on proper names, should come after Lesson 24, *i.e.*, before the study of prepositions, or, yet better, after Lesson 12, *i.e.*, between the study of the singular and the plural of substantives. The irregular verbs are grouped into twelve sets, dependent on the root-vowel modification that occurs in the principal tenses. We are inclined to join issue with Dr. Schlomka on his use of the word 'irregular.' He points out, on p. 185, that the word is an erroneous one, and that 'ancient' would be better. But as the words 'regular' and 'irregular' are used in other languages and in other grammars, he yields to the pressure of custom. The question is, whether a larger principle is not involved—that of accuracy, not only of word, but of thought. It is a question, however, too large for discussion here and now. The separable and inseparable verbs turn up again, and we would suggest to Dr. Schlomka whether he may not follow Ferdinand Schmidt's good example here, and get rid of these inaccurate names. A tabulated arrangement of the verbs would make yet more useful a book that is singularly able and complete.

Shakespeare's Henry VIII. With Notes, Examination Papers, and Plan of Preparation. London and Edinburgh: W. and R. Chambers.

'To what base uses we may return, Horatio!' Why may not imagination trace the noble work of Shakespeare till he find it made an examination subject? It is, alas! 'not to consider too curiously.' For the little book before us reminds us that Shakespeare is, like many other less excellent things, given over to the examination-Minotaur. As long as the examination fever affects our educationists, and even the public, in the main indifferent on these questions, so long, we suppose, Shakespeare must be put to this not very noble use. We are only too glad, moreover, that as early as possible our children should be brought face to face with the master. But it should be 'face to face.' They should, as we think, read him at first without note or comment, just as we see him enacted at the theatre. As it is, now-a-days, they only see him through a veil of notes and explanations, more or less accurate, that not only disguise him very carefully, but often disgust the young minds that are eager for the story and the poetry, and have a lordly carelessness as to details, philological or otherwise. The preparer of the 'Henry VIII.' seems half conscious of all this, for he has not placed his name on the title-page. He has, however, frequented, we should say, the British Museum Reading Room, and utilised Case 2,046, where the various editions of Shakespeare most do congregate. Hence we have the usual *olla podrida* of quotations from Johnson, Stevens, Pope, Holinshed, and so forth. These are as accurate and as uninteresting as ever. The notes containing these excerpts from experts, and a few explanations and paraphrases from our anonymous editor, are placed inconveniently at the end of the book. We have not read them all, but one, on p. 93, has caught our eye. The explanation of ''s death,' 'zounds,' is not full enough. If the ugly phrases are to be dealt with at all, let us deal with them accurately. The anonymous editor sacrifices precision to prudery. There are some hypothetical examination questions at the end. Their value, and in some degree that of examinations generally, may be gathered from a quotation of one of the inquiries: 'Discuss the characters (1) of Queen Katherine, (2) of Cardinal Wolsey.' This is questioning at large for schoolboys and schoolgirls.

Shakespeare's Plays for Schools. Abridged and annotated by Charlotte M. Yonge. National Society's Depository, Sanctuary, Westminster.

This book, designed especially to meet the requirements of English Schedule II., Code 1883, has as editress, Miss Charlotte M. Yonge. Her introduction to 'Henry V.' is written in polished and nervous English, and there is a summary of the play dealing briefly and succinctly with each scene. The customary list of persons represented becomes in part a genealogical table, Miss Yonge ingeniously grafting upon the Shakespearian names, extracts, so to speak, from what would have been the first column of the *Times* of the year 1415. Miss Yonge's notes have a more appropriate habitation than those of our anonymous editor in the book just noticed. They are placed at the bottom of each page of the letterpress, and are far more original, and not less explanatory than those already considered. In Miss Yonge's 'Henry V.,' however, as in the anonymous one's 'Henry VIII.,' there are no notes upon the thought and the dramatic construction of the play, points of far more interest and importance than chronologies and relationships, points also upon which young students most of all need guidance.

Robinson Crusoe. By Daniel Defoe. Edited for School Use, with Supplementary Notes, etc., by Alfonzo Gardiner. W. and R. Chambers.

In these days of artistic nursery books, Kinder-garten toys, and such school books as we have here, one almost regrets that one was not born later. Whether all these luxurious aids to training will result in a stronger and better generation of men and women, time alone can prove. No one can doubt that, in spite of all that may be said of undue pressure in the Board and State-aided schools, the road to learning is made now far easier than it was thirty or forty years ago. Education, as an art, has been acknowledged as such, and its professors trained for it as for any other profession. A few years ago any one who could read or translate a book from another into his native tongue, or could work questions in the ordinary rules of arithmetic or algebra, was supposed to be able to teach these subjects, and many a man can remember his master keeping his book open when he heard the Euclid class, and correcting with severity, and even punishment, such a mistake as the angle ABC for CBA. All this, we say, is past, and now, except in the very bad middle-class schools, of which we fear there are some still, teachers know how to teach and to use the fascinating aids prepared for them.

We should fancy that when 'Robinson Crusoe' is being read for the first time, the difficulty must be to keep the class' attention to the sentence being read and discussed, and, in fact, to get the children to deliver up their books at the end of the lesson.

The editor of this edition expects a great deal more than the mere reading of the text and realising of the

story. At the end of each chapter there are some very prosaic though useful exercises in word-forming and deriving. These are preceded by a glossary and short notes, giving the position of places, and even sometimes adding a little with regard to their government and history. To say that the book emanates from the firm of Messrs. Chambers, is to say that it is beautifully printed, and very attractive in appearance, and we wish the immortal, inimitable story all success in its new mission of teaching etymology.

Guides and Guards in Character-Building. By C. H. Payne, D.D., LL.D., President of the Ohio Wesleyan University, U.S.A. London: Hodder and Stoughton.

When an American divine, no matter of what denomination, is elected as a bishop or a president, we may take it for granted that he has distinguished himself as a preacher. America is essentially a land of talkers, and unless a man can talk well he can never hope to rise to the top of his profession.

Here in England men are not often appointed to high positions in the Church simply because they are good preachers; as a matter of fact, with one or two exceptions, our leading preachers are not bishops, and we have men on the bench who would never have had a chance of such advancement had their lot been cast on the other side of the Atlantic.

We open this volume of sermons, then, expecting, perhaps, a good deal more than we should, had it been prepared by an English divine; and we may say at once we are not disappointed.

The author in his preface tells us that the sermons make no claim to great literary excellence, and are published at the earnest request of some who heard them delivered and believed themselves benefited by them. With the exception of the first and last, Bible characters form the groundwork of the discourses; Joseph, Moses, Cornelius, with others, being taken as guides, and Absalom, Solomon, and Lot being amongst the guards. The sermon on St. Paul struck us as the finest. The author's admiration for the Apostle is very great, and beautifully expressed.

The book being printed from American plates we have to put up with their spelling of such words as traveler, theater, etc. The volume would make a charming and useful prize for any young man just entering life.

Shakespeare's King John. With Introduction, Notes, Examination Papers, and an Appendix of Prefixes and Terminations. By Thomas Parry, F.R.G.S. London: Longmans.

This is one of these well-known publishers' Modern Series, edited 'in accordance with the requirements of the Government Code.'

The introduction is very valuable, containing paragraphs on Shakespeare's grammar and versification; a history of the rival claims of John and his nephew, with the entire story of the play. Besides some twenty woodcuts, there is a map of the dominions of the Angevin kings. The notes are printed at the end of the book, and are just what a young pupil requires. The examination papers are arranged in two series, but are not as numerous as they might be; but the exercises on word-building are very useful. The text of the play is beautifully printed, and the volume generally is most attractive, and, considering its style, not dear, though we fear some school committees might think it too expensive to issue to their classes when so much cheaper copies can be procured.

Outlines of Mental Philosophy on the Inductive Method. By J. D. Morell, A.M., LL.D. London: W. Stewart and Co.

The author in his preface gives us a short account of the works of those who have investigated psychological questions from the basis of physiology, and he acknowledges the labours of these writers as giving him that on which he has based many of the doctrines brought forward in his work. He refers with special gratitude to the works of the German philosopher Herbart and his followers, and frankly says that 'though he has reconstructed the whole doctrine of the elaboration of ideas, their action and reaction, the method of their passing in and out of consciousness, their blending by the law of similarity, and their combination in groups and series, etc.,' that yet he feels the doctrine is due mainly to the labours of the Herbartian School, and that 'without their aid he would, in all probability, have never been able to combine the phenomena of the human mind, as they now appear, into one connected psychological system.'

The author distinctly tells us he has not pretended to enter with any detail into logical questions, and it is important that the student should realise this, or he might be disappointed at an examination in logic if depending on this work alone. We must agree with the author that if he has erred 'in the *execution* of the present handbook,' it is in having studied brevity a little too much. And we quite think with him that some may find the analyses too compressed.

The new word, 'residuum,' with, of course, its plural, 'residua,' is used by the author, and is acknowledged by him as a novel expression to embody a Herbartian idea; and this it seems to do very well.

Though the book is specially prepared with the idea of assisting candidates for the London degree; as such, it could be, and no doubt will be, immensely improved. Writers who are not accustomed to prepare, for the ordinary man, manuals with which to pass an examination, have little idea of what is required of them in this way. We are very much afraid that the ordinary university undergraduates would have great difficulty in finding the answers to many of the questions appended to the volume in the volume itself; but of that we shall speak again presently.

The subject is treated according to the principles of a natural science; in other words, as the title-page tells us, it is investigated on the *inductive method*. The author then lays down the eight points or principles on which all such investigations are based. Of these we have only room to notice one, viz., the sixth, which postulates the close connection between the different sciences, so that what is established in one science becomes afterwards data for the investigation of another. The tendency has ever been the opposite to this—to isolate mental science from the relationship it bears to other branches of inductive investigation. Mind was supposed to be so fundamentally distinct from matter, that no 'dependency could be traced between mental and physical science,' but now the author tells us, this distinction has been fully dissipated as a delusion, and it is at last acknowledged that 'mind, as the crown and summit of nature, cannot be reached as a valid branch of scientific research, except through the results of all the lower sciences.'

Every man may be almost considered as a perfect trinity—a three in one and one in three, for we find not only, as religionists would tell us, body, soul, and spirit, but, as mental philosophers tell us, a vital-force, a nerve-force, and a mind-force (including will); and these three stand in the closest correlation, the one supplying and often overtaxing the other. All this, and a great deal more, is very well worked out in the introductory chapter.

The work itself is divided into seven parts, and each part into from five to seven, and in one instance eleven chapters.

These chapters are of only six or seven pages, and being fairly complete in themselves would make a good division for regular reading and analysis.

As an appendix, there are some one hundred odd pages of examination papers, as actually set for the different examinations at London University. These papers are generally headed Logic and Psychology. Now if we turn to Part IV., 'On the Logical Processes of the Human Mind,' we only find some fifty pages on this important subject, and though no doubt they are admirably written and clearly arranged, still we doubt their being

enough, or nearly so, to enable the student to answer the questions given at the end of the book. Questions at the end of each chapter, or, at any rate, at the end of each part, would be invaluable to the student, and reference might be made, in some of the examination papers at least, to where the answers could be found.

Dr. Morell having published this volume as one of Messrs. Stewart's Educational Series, having also appended so many examination papers, and even got a 'London University graduate and experienced tutor, to eliminate from the text what would be unnecessary or confusing to the student, and to throw the whole into the form suited to the requirements of the London B.A. and other examinations, in which psychology is taken as a subject,' he must excuse us if we somewhat take exception to his work, valuable as it is, as a student's manual.

Had the volume been issued in the ordinary course, as a step forward of the Herbartian system of mental philosophy, we should have greeted it with more pleasure than we do. As such it will make its mark, but we doubt its being, from any point of view, as exceptionally valuable to the ordinary undergraduate.

The Church of England Sunday Service-Book, continuously arranged for 1885. Henry Frowde.

To quote the preface: 'The services are here given, without omission or alteration of any kind, in the precise order in which they are used in our churches, Sunday by Sunday throughout the year, so that they can be readily and intelligently followed, even by persons wholly unaccustomed to them.' This, of course, implies that morning and evening prayer are printed over and over again, the Psalms nearly twice, and other parts more than once. That there are Protestants to whom the arrangements of the English Church Prayer Book is a mystery, no one can doubt; and that many Dissenters like to attend the services of the Church on such days as their own places of meeting are shut, every clergyman knows well; but whether many will use this 'Sunday' Service-Book we doubt. If the publishers would issue separately, in the form of a very cheap manual, the entire services (including lessons), as used on such days as Christmas and Good Friday, we believe they would obtain an enormous sale for it. This volume will be of no use after 1885 until 1896, and even then the Psalms will be wrong for the first two months in the year. In 1891 the Psalms will be right, but the collects, etc., all wrong. One or two tables at the end of the book would, of course, render it perfectly usable at any time, but that, we presume, would militate against the publisher's idea of the advisability of procuring a new prayer book every year. The lessons are indicated, but not printed in full. It is suggested that the volume may save clergymen time in selecting subjects for their Sunday discourses, and were the lessons printed in full we should quite agree with this. The paper being necessarily thin, the printing is not as clear as it would otherwise be, but on the whole the appearance is attractive.

Introductory Lessons in Geography. Cassell and Co.

The early study of geography is now being made a delightful effort for the learner. He begins with observation of earth structure around him. Out of the mental images thus obtained, he elaborates by the aid of model and picture, a view of geographical facts which lie beyond the range of direct observation. Afterwards the map forms a symbolic representation of his knowledge. Just as words follow and symbolise our ideas, maps symbolise and follow the geographical facts obtained by observation. These 'introductory lessons' follow the principles enunciated above. The garden is pictured for observation, the plan follows and symbolises it. Similarly the schoolroom, the playground, and the village—all these are first presented in picture and then in plan.

The consideration of 'scale' is introduced too soon. The diagrams in the first part of the book are admirable; the cuts on pp. 55, 59, and 63, might, with advantage, be entirely omitted.

Local Examination History. Dr. Pringle. J. Heywood, Manchester.

Notes of historical events and characters are essential aids to the student who wishes easily to retain and readily to recover the facts of history. Notes are especially valuable to the pupil preparing for an examination. That this book has now reached the fifth edition is proof of the demand for such assistance as it affords. As educationists we have most faith in the value of the 'notes,' which a student of history compiles for himself; such notes will necessarily be the outcome of the pupil's thought, and the facts they register will be readily recalled, together with the events surrounding them. Dr. Pringle's notes, used within the limits suggested in his preface, will help the pupil and relieve the teacher.

Formulæ and Equations. By Rev. T. W. Openshaw, M.A. London: Bell and Sons.

This little book presents in a convenient form the most important formulæ in algebra, plane trigonometry, mensuration, and analytical conics. As stated in the preface, it is intended for teachers as a hand-book of test questions, and for students as an aid to the ready production of their mathematical knowledge. It contains a few printer's errors, mainly in the earlier part of the book, while the author uses a few symbols which may be new to his readers, *e.g.*, $n!$ in place of $\lfloor\underline{n}$. It is perhaps rather unwise to introduce determinants so early in the work as the section on the straight line. We can recommend the book as a useful companion the evening before the mathematical papers of either examination for the London B.A.

The New Royal Readers: Standard VI. London: T. Nelson and Sons.

This volume completes the new and admirable series of reading-books just issued by the famous Scotch house whose imprint they bear. We may at once say that the excellence of its predecessors, to which we have cheerfully borne testimony, is fully maintained in the serviceable volume before us.

It contains one of the choicest selections of standard English literature it has been our privilege to see within the compass of an ordinary school-book.

Each lesson, which is broken up into paragraphs of convenient length, is followed by a list of new words (accented), copious notes and meanings, summary, and exercises. The succinct notices of authors—such as that given of Charles Dickens on page 12—cannot be too highly praised, and should be stored in every child's memory. But the special merit of this literary reader—and the one which, in our judgment, will most commend it to inspectors as well as teachers—lies in the fact that it contains the finest scenes of Sir Walter Scott's masterpiece, 'Ivanhoe.' Our readers will know with what graphic vigour this tale has been told, when we say that the author's own words have practically been retained throughout.

Of the type, illustrations, paper, printing, and binding, it is unnecessary to speak; they are perfect. We may add that a cheap and carefully compiled series of companion Home Lesson Books may now be had from the same publishers.

An Epitome of History, Ancient, Mediæval, and Modern. By Carl Ploetz. Translated, with extensive additions, by William H. Tillinghast, Harvard College, Cambridge, U.S.A. London: Blackie and Son.

This is an English reprint of an American translation of a German educational work.

Dr. Ploetz, we are told in the preface, is well known in Germany as a veteran teacher, and author of several educational works.

In England our upper classes are generally provided with a history, and expected to get up a certain portion of it to be questioned on. In Germany such subjects are taught in the form of a lecture, the students writing as hard as they can the whole time, in order that they may reproduce the lecture or lesson in as intelligible and concise a form as possible. We have no doubt that this volume gradually grew in this way, viz., that the learned Professor worked up his notes, from which he had lectured, into their present form as a model on which his pupils ought to reproduce what they had heard. In the course of years, period after period was gone through, until the notes in the aggregate became, as they are called in Germany, an 'Epitome of Universal History.'

We are indebted, though, to the American translator for any history at all of some nations, as Japan, Parthia, and for the enlargement of other accounts, as of those of India and France.

The histories of America and England have been re-written, and thus rendered as full as that of Germany. The minuter details of the Austro-Prussian and Franco-Prussian wars have been omitted.

The index to the work is so full and well arranged that the volume becomes a short historical encyclopædia, and this renders it, to one who has read a fair amount of history, a most valuable book of reference.

As a manual for ordinary schoolboys, unsupplemented by first-rate lectures from a thoroughly-informed teacher, it would be of very little value, being naturally very difficult and uninteresting; but to a master or other, wishing to give a course of lectures on any particular period of history, we know of no better book. In fact, if references to authors were given, where details could be found, the book would be well nigh, for this purpose, perfect; yet we must, in fairness to the translator, add that in the new ground taken up by him he has given the origin of his remarks. There are several genealogical tables, drawn out in the usual way, and inserted in the text. The English publishers have not thought it right to change the spelling of words where the Americans differ from us. In its appearance the book is attractive, being well printed and strongly bound.

Sixth Reader. London: Blackie and Son.

This is the last of these publishers' series, adapted for the different standards according to the new Code. The readings vary in length, from a sonnet to an essay or description of some five or six pages. The subjects introduced are very numerous, written by authors of the last three centuries, including such names as Spenser, Addison, Herschel, Washington Irving, Dickens, and Ruskin, with many others. At the end of the book there is a list of words derived from the Latin, with another of the Latin words themselves, giving, in the case of verbs, that portion of the Latin words whence the English equivalent is formed, the simple English being inserted in brackets, thus: 'Caedo, caesum [I cut, kill]; concise, decisive, homicide, incision. In addition to these hints, there is a glossary of the more difficult words.

Considering the clear print, the strong binding, and its cheapness, it ought to demand a large sale.

PRIZE BOOKS.

MESSRS. HODDER AND STOUGHTON'S LIST.

First Notice.

THESE well-known publishers have issued, as usual, a number of prettily-bound, well-printed, and, in some instances, beautifully-illustrated volumes, to be given as prizes at the close of the current term, or as Christmas presents.

All the books before us are of a decidedly religious turn, and do a great deal more than what is generally termed point a good moral. In one instance, as will be seen below, we are almost afraid the authoress has gone too far; and we cannot but fancy she would have done better had she left much of what she has said, good and true though it be, to be read, as it were, between the lines. At the same time, we cannot but congratulate prize-givers—of whom, happily, there are so many—that they can so fearlessly distribute Messrs. Hodder's publications without examining them.

In these days of freethought one ought to be particularly on the alert as to what books fall into our children's hands, as a careless prize-giver may unwittingly do incalculable harm in presenting an attractive volume, without thoroughly examining its contents. If these volumes be, as we believe they are, fair specimens of the prizes issued from Messrs. Hodder and Stoughton's house, teachers, and parents, and present-givers generally, need, as we have said above, have no hesitation in ordering them *en masse*.

(1) The Orient Boys: a Tale of School Life.

The name of the author of this story is not given, nor are we told on the title-page that he or she (probably the latter) has published anything before. We do not require to be told that the volume is printed from American plates, for, before we have read two pages, we feel that we are, nor can be, in no English school. English boys, no doubt, will be interested to know how their New England cousins comport themselves at their schools. If this be a true sketch—as we doubt not it is—then we hear new expressions, and find lads figuring under circumstances in which they would never be found in this country. Still, there seems to be there, as here, very much the same mixture of noble boys and mean, industrious boys and idle ones, even religious boys and irreligious ones.

A hot-blooded Cuban, sent to the north to escape tropical ailments, is, perhaps, the most interesting sketch; and how he obtained mastery over himself and his fiery temper is, we think, the most useful lesson in the book. The bad boy who, directly and indirectly, does all sorts of harm, is not so interesting. Nor are there in any way indicated those slight signs of underlying goodness which, we feel sure, must have been at times apparent in one who changed as much as he is represented to have done.

There is what we might almost call quite a theatrical death-scene, which reminds one of that of Eva amidst her slaves, etc., in 'Uncle Tom's Cabin.'

The three principal characters pass from school to college; but, whilst there, interrupt their studies by joining the Northern Army during the Great Rebellion; but of their experiences as soldiers we hear very little. At the end of the war they conclude their studies, as hundreds of the young volunteers did; and we leave them married and useful.

(2) Meg's Mistake, and other Sussex Stories.

By Mrs. Robert O'Reilly.

Though the bulk and price of this volume is precisely the same as the others, there is nearly twice as much matter in it, the print being smaller, though comfortably readable by even older eyes.

Mrs. O'Reilly is one of our most successful short-story writers, and every one knows how far more difficult it is to write a good short story than a longer one. We presume by putting 'Meg's Mistake' at the commencement of her volume, the authoress thought it the most worthy to lead the other stories before the world; we cannot think so. If ever these stories be published separately, we fancy others of them will be found more popular than 'Meg's Mistake.'

'Miss Olive's Boys,' for instance, is a charming sketch of thirty-five pages, as to how a nature-loving, simple-hearted squire's daughter may influence a lot of country boys with her intensity and reality. She has a class in the Sunday-school, and though she has far less to teach them than others of Biblical facts, etc., she has a very strong feeling of right and wrong, and all her lads more or less; feeling first that she cares for them to do right, and learn to try and live more as they ought to from higher motives.

The crowning story of the book is, we think, one called 'A Golden Wedding,' in which there is a wonderful old heroine, deserted and neglected, living on, confident that her old man will return to her when he wants her, which, of course, he does. The illustrations by that well-known

artist, Fred. Barnard, are wonderfully graphic, and are certainly a real addition to the book.

(3) **Just in Time; or, Howard Clarion's Rescue.** By Mrs. G. S. Reaney.

Beautiful in many ways as this book is, earnest as the direct religious teaching is, we confess we are at a loss as to what boy or girl we should wish to present it. The story opens in the nursery of a grand house, where we find a poor little boy disgracefully neglected by his pleasure-loving mother, and positively ill-treated by a deceitful nurse. His only friend seems to be a young servant who talks religion to him, and who loses her place by trying to make the mistress understand the true state of affairs in the nursery. We have in this chapter some valuable remarks about children's prayers and children's services. In the third chapter we find this poor neglected child as an undergraduate home for a vacation, being upbraided by his indignant mother for drinking too much champagne at *her* table. We then find him painting in North Wales, where he sees and falls in love with a pretty country girl of the middle class, whom he marries in haste. After this, he goes from bad to worse, deserting his wife and child, until we find him all but ruined in the hands of an unprincipled man and woman, who have him entirely in their power. Here (we will not tell how) the poor wife finds him, and succeeds in getting him home, so at the last becoming, as the title-page tells us, 'rescued, just in time.' The faithful servant of his baby days turns up again, and is found doing a good work wherever she goes. In addition to her, there is another religious servant, who plays an interesting and useful part in the story.

Now for whom, we ask, is this book suitable as a prize? For little children it would certainly be of none. Elder girls, perhaps, might learn to be careful how they allowed their young hearts to be influenced by those of whom they know but little. Young men, too, might, no doubt, be warned against the evils of drink and dissipation; but, would they read it?

At the same time, no doubt, there are very useful lessons to parents, in the higher stations of life especially, as how they firstly leave their children to unprincipled nurses and governesses, and secondly, commit their daughters' happiness to men whose position and incomes may be good, but whose morals are weak and vacillating; but such have got beyond their prize-receiving.

(4) **A Long Lane with a Turning.** By Sarah Doudney.

Like all this gifted authoress's stories, this is not only exquisitely written and true to life, but breathing with an unobtrusive religion. In the course of the book, one of the characters says to the heroine, when asked why she did not marry:—'In my young days I had to choose between Lancelot and Arthur, and I took Lancelot, as nine women out of ten would have done. And then, Mary, I had to let him go. Do you understand?' And so in fact was the experience of the heroine herself, though the speaker knew it not. She, too, had chosen Lancelot, and had to let him go. To show how beautifully the story is welded together, we find it almost impossible to refer to a single character in the book without telling more of the plot than it would be kind to do.

Miss Doudney is evidently very fond of that old fashioned, yet ever fresh allegory, the 'Pilgrim's Progress.' We hope that the allusions to it may lead some to refresh their memories with its wonderful beauties and immortal lessons.

The authoress is assisted by Miss Edwards, who furnishes some sixteen full-page engravings, drawn with her usual power.

The Try Arithmetic. For all Classes of Schools. By Dennis Heywood, C.M. John Heywood.

This book consists of a very large collection of examples, carefully arranged in sets, generally of four, sometimes of as many as seven. The work is divided into six parts, corresponding to the requirements of the different standards, and each part into four quarters—the last quarter of each part being 'Inspector's Tests,' given in the same form as received by the children, when being examined. Before the 'Inspector's Tests' come problems, where the child has to make his own statement. These sets of fours are named after the letters of the Alphabet, increasing in difficulty, so that the questions under X, Y, Z, require more careful working, or are more difficult to state, than those under the earlier letters of the Alphabet. In the higher standards, each Alphabet receives some special name, as for instance, 'Miscellaneous Examination.' This, of course, is done for easy reference—so that a teacher simply has to give out for home-work, say Standard IV., Reduction, K; or, Standard VI., Vulgar Fractions, R; or Examinations, G. The author assures us in his preface that teachers in large schools have found the book eminently useful and time-saving, and this we can well believe.

Matriculation Hints.

By Henry A. Reatchlous, M.A. (Lond.), B.Sc.,

Westminster Training College.

The subject of heat is usually included in the manuals on Natural Philosophy. The student may refer to these, and among them to Everett's 'Text-book of Physics' (Blackie and Co., 2s.), and to a little book called 'Lectures on Heat,' by Dr. Wormell (Murby and Co., 1s.). Professor Garnett's 'Elementary Treatise on Heat,' (Bell and Sons) is a very excellent book. With the syllabus before him, the student can select the parts specially named, and devote most of his attention to them.

Notice is first drawn to the sources of heat. These are enumerated by Professor Garnett as (1) radiant energy; (2) chemical action (including combustion); (3) mechanical sources as in the case of friction and impact, etc.; (4) electrical currents; (5) change of state, as when steam is condensed into water; (6) internal heat of the earth (the last being only a source of heat previously accumulated). The next, and very important point is to distinguish clearly between temperature and heat. Temperature is the state of a body considered with reference to its power of communicating heat to other bodies (Wormell). It is a quality, not a quantity; it is estimated in degrees by instruments called thermometers. Heat is a measurable quantity, a form of energy, and is expressed in thermal units, or in the number of ergs equivalent to them. The thermal unit now most commonly used is called a calorie; it is the amount of heat required to raise the temperature of one gram of water from 0°C. to 1°C. Instruments for measuring quantities of heat are called calorimeters.

The subject of thermometers is, including the conversion of degrees from one scale to another, explained fully in the text-books. The use of a weight thermometer should be understood (Everett, page 105). If we assume the absolute expansion, we are thus able to deduce that of the glass we are using, and then, by observing the apparent expansion of any liquid, we can find its absolute expansion.

A gas expands $\frac{1}{273}$ of its volume at 0°C. for each degree centigrade. Hence, V_0 be the volume at 0°C., and a be the co-efficient of expansion, the volume at any other temperature t will be $V_0(1+at)$; and, similarly, at any other temperature, T, it would be

$V_0(1+aT)$; hence the ratio of the volumes at t and T $= \frac{V_0(1+at}{V_0(1+aT} = \frac{1+at}{1+aT}$.

This result is made use of in determining the value of a. If we know the volume of a gas at, say, 15°C., and the volume of the same mass of it at 100°C., then a can be determined from the equation $\frac{V_t}{V_T} = \frac{1+at}{1+aT}$. If we keep the volume constant while the temperature is raised, the pressure of the gas will increase, and if the pressure at temperature t and at temperature T be observed, we can determine a from the relation $\frac{P_t}{P_T} = \frac{1+at}{1+aT}$. The zero of temperature is often taken to be that at which ice melts under a pressure of 760 mm. of mercury. What is called the absolute zero of temperature is 273° below this. Hence, we can express the absolute temperature by adding 273 to the ordinary centigrade reading. Assuming T to stand for the absolute temperature, V for the volume of a given mass of gas, and P for the pressure under which it exists, $\frac{PV}{T}$ will be a constant quantity, whatever be the special values of P, V, and T. This is a neat formula for solving such questions as the following:—

(1) 20 litres of air are measured off at 15° C. and 700 mm.; what volume with they occupy at 30 C. and 760 mm.?

$$\frac{PV}{T} = \frac{P_1V_1}{T_1} \quad \therefore V_1 = \frac{PV}{T} \times \frac{T_1}{P_1} = \frac{700 \times 20 \times 303}{288 \times 760} = 19{\cdot}4$$

(2) The volume of a gas is increased by one-half, while the pressure under which it exists is increased by two-thirds, if the temperature were originally 15° C., what would it be finally?

$$\frac{PV}{T} = \frac{P_1V_1}{T_1} \quad \frac{PV}{288} = \frac{5P \times 3V \times 1}{3 \times 2 \times T_1}$$

whence $T_1 = \frac{288 \times 15}{6} = 720$ abs. $= 447°$ C.

Attention is called to specific heat, latent heat, and the instruments for determining them. The student is strongly advised to determine for himself (roughly, of course) the specific heat of a few metals. Instructions for this are given on page 79 of Dr. Wormell's Lectures. He should also find the latent heat of water and steam by the method of mixtures. To determine the latent heat of water, place a known weight of water at a known temperature into a calorimeter (which may be a small tin canister). Add fragments of ice, previously dried with blotting-paper. Observe the temperature when the ice is just melted, and then weigh, so as to determine the quantity of ice used. Suppose we had W grams of water to start with a temperature T; that we used M grams of ice, and that the final temperature was t; put x for the latent heat of water, then $WT - Mx = (W+M)t$. Several corrections must be made to get a good result: the specific capacity of calorimeter is the most important of these. But it is much better to try the experiment without corrections than omit it altogether. The method of obtaining the latent heat of steam is described in Professor Garnett's 'Elementary Treatise,' on page 102. Into a current of steam is passed a known weight of water at a known temperature, and when the temperature has risen some degrees the jet is removed. Putting x for the latent heat of steam, and using the same letters as before, we should have—

$$WT + Mx + M \times 100 = (W+M)t.$$

It is worth while to note that the latent heat of steam varies with the temperature at which it is produced. It requires 100 thermal units to raise one gram of water from 0° to 100° C., and 537 more to convert it all into vapour at 760 mm. pressure, giving a total of 637; at 90° C. the latent heat is 554, at 110 C. it is 529. The general phenomena of boiling should be carefully observed, and experiments to show the dependence of the boiling point upon the pressure devised. Small bottles can be filled with water and placed in a freezing mixture (salt and pounded ice); they will burst as the water becomes converted into ice. Melt a paraffin candle in a glass beaker, notice the great contraction upon solidification. The melting point of bodies which expand in solidifying is lowered by pressure, while it is raised for bodies which contract.

Heat can be transferred from a hotter to a colder body by conduction. Conduction of heat is always from a hotter to a colder part, and the process is always comparatively slow. The conducting power of two bars cannot be determined by the rapidity with which enough heat travels down equal lengths of them to ignite a piece of phosphorus. We must wait until the flow of heat is steady. When it is so, the number of thermal units that flow through one unit of area of a plate of unit thickness, its two sides being kept at unit difference of temperature, is called the specific thermal conductivity of the substance. Let the area of a plate be ab, its thickness c, T the temperature of one face, and S of the other, and K the conductivity; then the number of thermal units that pass through it in t seconds is $\frac{abtK}{c} \times (T-S)$.

How much heat is conduced through a plate of iron in 20 seconds of 40 cm. length, 6 cm. breadth, and ·5 thickness, the faces being kept at 90° C. and 100° C. respectively (the conductivity of iron is ·16). Ans. $= \frac{40 \times 6 \times 20 \times \cdot16 \times 10}{\cdot5}$ $= 15{,}360$ calories.

Heat can also be transferred from one body to another, from a hotter to a colder, and from a colder to a hotter, by radiation. A block of ice melts when placed near a fire; the heat it receives from the fire is greater than the heat it radiates to it. If we put different substances at equal distances from a source of radiation some will get hotter than others; they will absorb more heat. Bodies which absorb heat readily radiate it readily, lamp-black being the best radiator known.

There is no real difference between light and radiant heat. Rays which cause the sensation of light also cause a sensation of heat, but some rays which excite the sensation of warmth do not affect the sense of sight. Some bodies allow light to pass through them more or less completely; this is also true with regard to heat. Examples should be learned. Remember that the heat which is neither reflected nor transmitted by a body is absorbed by it, and raises its temperature.

When heat is applied to the bottom of a test-tube, the water immediately above it becomes warmer and specifically lighter (if not between 0° and 4° C. at the commencement), and rises. This mode of transferring heat is called convection. It is by convection that gases and liquids are generally heated. Simple experiments with coloured water to show convection currents should be practised, the explanation of winds, ventilation and ocean currents understood.

(To be continued.)

The Practical Teacher.

A Monthly Educational Journal.

To Subscribers.—The *Practical Teacher* is published on the 25th of every month. Price 6d.; post free, 7½d.; sent post free, three months for 1s. 11d.; six months, 3s. 9d. a year, 7s. 6d.

P. O. Orders should be made payable at Chief Office.

Subscribers not receiving their copies regularly are respectfully requested to write to the Publisher.

It would save time and expense if subscribers when remitting would state exactly what numbers they wish to be sent.

To Correspondents.—All literary communications should be addressed, The Editor of the Practical Teacher, Pilgrim Street, Ludgate Hill, London, E.C.

Accepted contributions are paid for within twenty-one days of publication.

The Editor cannot return rejected MSS.; authors should therefore retain copies.

TO ADVERTISERS.

Approved, *prepaid*, advertisements will be inserted in the *Practical Teacher* at the following rates:—

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Parts of a page are charged at a slightly higher rate.—Special quotations will be given for a series.

Portfolios, fitted with elastic bands, for preserving twelve numbers of 'The Practical Teacher,' may now be had. Price 2s. 6d. Orders should be given through booksellers.

The numbers of the *Practical Teacher* for February and March, 1884, are now out of print.

Gossip.

This month, in place of the usual Pupil-Teachers' Questions and Answers, we have the pleasure to present our readers with the major part of '*My Certificate Answers*,' by Mr. Arthur Day, who won the post of honour in the Borough Road Training College List. The answers are as nearly as possible those which the writer set down at the Certificate Examination. It will, doubtless, interest a large number of our correspondents to learn that, appended to the complement of the answers, which will appear in our next issue, will be found a list of the books used by Mr. Day.

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In future, Pupil-Teachers will be examined only twice a year. Those whose school year ends from the 31st of January to the 30th of June, will 'sit' on the last Saturday in April, and the others on the last Saturday in October. This important change, while economising the time of the Inspectors, will tend to secure a greater unanimity in the *standard* of examination, and will, doubtless, encourage what is generally known as the Centre Training of Pupil-Teachers (Art. 110).

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Instead, therefore, of having eleven examinations, there will henceforth be but two. This arrangement will, by placing considerable additional space at our disposal, enable us to introduce into our pages several most valuable subjects, which cannot fail to render our journal increasingly attractive and serviceable to students and teachers. Particulars of these new features will be announced in our next issue, and we trust our friends will kindly make known the changes as widely as possible.

Messrs. Jarrold and Sons announce a new edition of their handy 'Teacher's Diary and Pocket-Book,' which for the past two years has found, and deservedly so, much favour in the profession. Mr. A. Johnston, of 6, Paternoster Square, has recently issued a new series of Copy-Books—including a kindergarten book—which we hope to notice next month. The Messrs. Nelson have also just published the last volume in their well-known series of 'Royal Readers.'

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Teachers on the outlook for prizes will be glad to hear that the current season promises to be an exceptionally busy one. From Messrs. Blackie and Son and Messrs. Hodder and Stoughton we have already received consignments of elegantly bound prize-books. In our next issue we shall have a special notice of them. Meanwhile, those of our readers who use prizes, and wish to know something of the coming books, cannot do better than drop a line to any of the following firms, who will gladly furnish a full descriptive catalogue of their respective publications:—

Messrs. T. Nelson and Son, Paternoster Row, London, E.C.
Messrs. Blackie and Son, 56, Old Bailey, London, E.C.
Messrs. Griffith and Farran, St. Paul's Churchyard, London, E.C.
Messrs. Sonnenschein and Co., Paternoster Row, London, E.C.
Messrs. Hodder and Stoughton, Paternoster Row, London, E.C.
Manager, Religious Tract Society, 56, Paternoster Row, London, E.C.
Messrs. Relfe Brothers, Charterhouse Buildings, London, E.C.

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This year a new annual will be published by Messrs.

A. Brown and Sons, Hull, under the title of the '*Scholastic Christmas Annual*,' edited by Mr. William Andrews, Secretary of the Hull Literary Club. In addition to tales and poems by a number of well-known authors, chapters will be included on 'School Ways and School Days in China,' by the Rev. Hilderic Friend; 'The Rod in and out of School,' by John H. Leggot; 'The Horn-Book,' by the Editor; 'The School Days of Shakespeare,' by James Gibson; and other papers bearing on scholastic subjects.

***

We beg to remind our readers of the announcement at the foot of our title-page. The *French Lessons* which are begun in the *Scholar* for November have been prepared by an experienced teacher, and will be found most carefully graduated.

The Value of Written Reproductions.

BY EDWARD R. SHAW,

Principal High School, Yonkers, N. Y.

NOT one of all the aids to language training is of greater value than reading to a grade or class a selection, and then requiring them to reproduce it in writing. In examining courses of study from scores of town and city schools, we find a wide recognition of the value of this exercise in directions like the following: 'Writing abstracts from memory;' 'Pieces read to grade and grade required to write them out from memory,' etc.

The value of these exercises consists, in the first place, in enlarging the pupil's vocabulary, and that, too, in the most natural way, because he grasps the ideas and thoughts lying behind the words; he grasps them, moreover, in a way that he does not in reading lessons, from the fact that he is to reproduce the thought, and will naturally do so in calling up the identical words of the selection.

Further, the pupil in writing out what has been read to him, is having a most valuable exercise in spelling and punctuation.

In the reproduction the pupil is constructing sentences that are related to each other in thought, and is therefore working in keeping with the idiom of the language—the way that all command of language is gained. How different the sentences of a reproduction, connected as they are in thought, to those detached ones, mechanically made to comply with some stated requirement imposed by the teacher!

Then there is a development of the imagination in these exercises. Of course, it is what we may term the reproductive imagination that is trained, and not the creative; but the reproductive must be made active in order that the creative may develop. In these reproductions there is always food and exercise for the imagination, and this undoubtedly accounts for the pleasure experienced by pupils in doing the work.

But while so much growth in language, spelling, composition, imagination, and appreciation of style results from the exercises of which we are speaking, there is comparatively little of this written reproduction work. It is doubtless in consequence of the fact that teachers are unable to find, at their command, sufficient material for the work. The selections must possess certain qualities, without which they are of little value, and if selections lacking in these qualities are read to a class, the attempted reproduction will result in failure and discouragement both to teacher and pupils. As a first requisite, the selection must be a perfect and striking whole, and for commencement work should be largely narrative. It must be such that the pupil can easily grasp it. It must make upon his mind a forcible impression; for if it leaves only a vague impression, his working it out will be obscure and disconnected.

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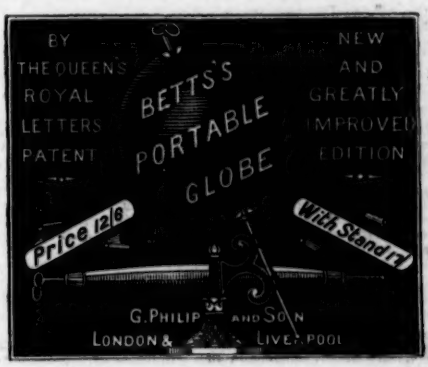

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